A ROMAN LONDON PROBLEM

DISCOVERY

A Monthly Popular Journal of Knowledge

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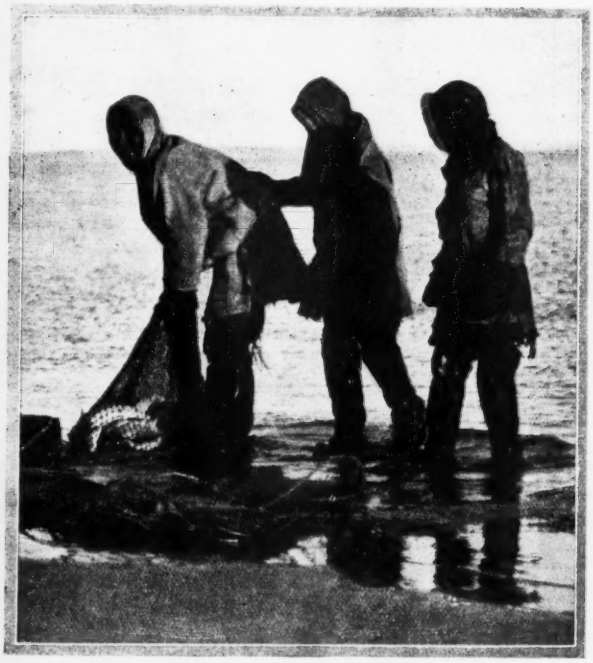

SAMOYEDE FISHERMEN IN SIBERIA.

DISCOVERY

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Trustees: Sir J. J. Thomson, O.M., F.R.S., Sir F. G. Kenyon, K.C.B., F.B.A., Professor A. C. Seward, Sc.D., F.R.S., Professor R. S. Conway, Litt.D., F.B.A.

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Editorial Notes.

In view of the attention that has naturally been directed to the opening of public wireless telephony between London and New York, our readers will learn with interest that the first British commercial newspaper to make use of the new service was *The Timber Trades Journal*, the weekly publication associated with *Discovery*, being also issued by Benn Brothers Ltd. Though the inauguration of this new link with America took place on 7th January, it was originally intended that the official ceremony should be performed a week later; in consequence, when the earlier date was announced only two days beforehand, there was a considerable rush to put in calls for New York. Among the first firms who had already done so—if not actually the first—were the well-known London timber importers, Messrs. Bambergers, at whose offices in the City an event took place which in days to come will be of historic interest. It had been anticipated that the call would be received at 5 p.m., but it was not until 10.15 p.m. that Major Bamberger spoke with the president of the South-East Lumber Co. of New York and placed the first wireless business contract—appropriately for an amount of timber which, cut into inch square strips, would bridge the intervening ocean. The telephone was then handed to the editor of our associated journal, Mr. Mortimore Sparks, who addressed the first words by the new service from a British trade journalist to one of his American contemporaries.

Another important development in communication witnessed since the new year was the successful conclusion of the first official flight to India by way of the new Imperial Airways line from Cairo to Karachi. As anticipated in our Christmas number, the Secretary of State for Air and Lady Hoare reached India on 6th January, after a flight of eleven days from England. Despite several slight mishaps, the Hercules machine in which the party travelled reached its final destination within twenty minutes of scheduled time, and so concluded the first flight of this distance—over 6,000 miles—to be accomplished to a time-table calculated in minutes. It is particularly fortunate that this initial journey was so entirely successful according to detailed plan, not only as a tribute to the skill and energy of those responsible for the new air service, but as an example to the world at large of a sphere of enterprise in which the British Empire is undoubtedly well to the fore. Sir Samuel Hoare proceeded from Karachi to Delhi, in order to inspect the Royal Air Force stations at the principal intervening points. By an interesting coincidence, on the same day as his machine reached its final destination, two amateur British aviators, Mr. Stack and Mr. Leete, landed their De Havilland Moth light aeroplanes at Karachi, having left England in November, and so also added a hitherto unparalleled achievement to the history of British flying.

* * * * *

The first greeting card to be sent by wireless reached London on Christmas Eve, being sent from New York by one who has been prominently associated with American activities in Europe. The picture was received at Marconi House, whence copies were dispatched by air mail to several well-known people on the Continent, including, it is reported, at least two crowned heads. We do not record the incident for the somewhat romantic circumstances that must have rejoiced the 100 per cent American mind responsible for this particular extravagance, which indeed seems scarcely more ludicrous than anything conceived by Mark Twain in his "Yankee at the Court of King Arthur"; but as a case now becoming typical in

which the latest discoveries are accepted as a matter of course even when associated with matters having centuries of tradition behind them.

* * * * *

As a resu't of the recent question that was raised in Parliament and in the London County Council regarding the erection of a planetarium in England, renewed interest attaches to the article on the subject which appeared in *Discovery* in September, 1925. Dr. J. Jackson, of the Royal Observatory, Greenwich, advocated in a recent issue of *The Times* the value of the planetarium for giving the public an insight into the motions of the heavenly bodies, and in the same issue was published an illustration of the instrument at Munich that had appeared over a year previously in our pages. The letter recalled that in 1913 the authorities of that city proposed to the optical instrument firm of Zeiss, at Jena, that it might be possible to construct an artificial sky in the form of a dome on which images of the stars and planets could be projected. A few experiments soon showed the value of the idea, but the project was deferred by the war. In 1924, when the new planetarium was eventually constructed, it was set up—before dispatch to Munich—on the roof of Zeiss's works, and it proved such a success that the makers subsequently built a larger and improved instrument for Jena itself; others have already been made or ordered for at least a dozen other towns in Germany. We understand that the practicability of instituting a planetarium in England is now under consideration by the public authorities mentioned; incidentally, the first inquiry we received for information in this connexion was from the London County Council.

* * * * *

Writing in *The Times* last month, Mr. Leonard Wooley described further discoveries of the first importance that have been made at Ur in Mesopotamia as the result of continued excavation by the joint expedition of the British Museum and the Museum of Pennsylvania University. The object of the winter season's work was two-fold—to secure more literary tablets and to acquire knowledge of the conditions of domestic life at an early period—and in both respects it has been highly successful. Apart from scattered finds, three distinct hoards of tablets have come to light which, instead of the business documents commonly discovered on the site, are all of a literary or scientific character. With regard to the buildings where these tablets were found, Mr. Wooley states that it is the first time private houses of the period have been discovered, and that the discovery changes altogether our ideas of how men lived at the period of their construction in 2100 B.C., which was about the time when Abraham was living at Ur. Particularly striking is the high degree of comfort and even luxury to which the ruins bear witness, some of the two-storied buildings solidly constructed in burnt brick being almost exactly like the best houses of modern Baghdad.

* * * * *

Among the discoveries only one of the rooms unearthed completely puzzled the expedition. This was distinguished by having in front of a niche in the end wall a raised block of brickwork like an altar, round which, under the pavement, nearly thirty large bowls containing the bones of little children were found close together. While it was a common custom to bury the dead under the houses in which they had lived, it is hard to believe that in a single household, and within a comparitively short space of time—the buildings appear to have been inhabited for some two hundred years—so many babies should die a natural death. As there was no Moloch in the Sumerian pantheon to demand infant sacrifice, Mr. Wooley concludes that perhaps we have here a domestic shrine dedicated to some deity kindly to children whereto friends or relatives might bring their little ones for burial. If so, there was in the Sumerian religion of Abraham's time a sentiment more intimately human than the texts would lead us to suppose.

* * * * *

In our last issue the excavations so far carried out on the ancient Maya site of Lubaantun in Honduras, under the auspices of the British Museum, were described by Mr. T. A. Joyce, who pointed out that it was proposed to start on a further expedition to the Colony at the end of January. An appeal for funds to carry on the work has subsequently been issued by Sir Frederic Kenyon, Director of the Museum: the annual cost of the expedition will be about £2,000, and a capital sum of £50,000 is asked for, in order that continuity of operation may be maintained. This is essential owing to the extremely rapid growth of tropical vegetation, which considerably increases the work of clearing the forest sites if a single season is missed. While it is hoped that much of the money required will be forthcoming by the time this issue is published, when the further expedition should already be on its way, we are sure that in view of his connexions with *Discovery*, support from its readers will be especially appreciated by Sir Frederic Kenyon, to whom donations should be sent.

Roman Pottery in Britain: A New Problem.

By Gordon Home.

Author of "Roman London," "Roman York," etc.

During recent excavations on a Roman site in London, the author discovered a series of examples of datable material, in circumstances that raise an important problem as to the early history of Roman pottery in Britain. Unless some satisfactory explanation be forthcoming the facts presented would seem to raise doubts as to the hitherto widely accepted system of dating such pottery.

THE great difficulty that has confronted archaeologists in studying the Roman period of London has always been the fact that the excavations which are constantly being made are for other purposes than shedding light on the city's past. Area after area of the most important central portion of Roman London has been dug into during the last half century, and one can literally say that cartloads of Roman objects, or more accurately, enough to fill several carts, have been found and preserved—to some extent in the three London museums and the balance in private hands. Apart from all this there has been taken from the Roman levels, without the slightest examination, a huge total of cubic yards of soil containing, undoubtedly, a vast accumulation of objects of the Romano-British period.

From the many nearly complete and the few perfect vessels discovered has been made a large collection of pottery, representing the whole of the varieties of household ware used in Londinium between the first and the fifth centuries of the Christian era. Besides the earthenware there is quite a considerable number of objects of bronze and bone, and a smaller proportion of iron, gold, silver, and wood, but among them all, apart from the few discoveries bearing some form of inscription which approximately date them, there are only a very few that can be ascribed to any particular year or short period, *unless* one relies upon the system of dating of pottery built up by Dragendorff, Déchelette and others.

The System of Dating.

This system has for several years past formed the basis for nearly all archaeological attempts at dating when there is no absolute evidence from inscribed monuments or the risky testimony of coins. It postulates that the red glazed ware, commonly known as Samian or *Terra Sigillata* (=stamped ware) was manufactured at Arretium, in Italy, as early as 150 B.C., and was developed in Roman Gaul until about A.D. 260, when the potteries were destroyed or ceased working owing to barbarian invasion. On the basis of these facts it would naturally be assumed that the importation of this earthenware into Britain was continued as long as the manufacture endured. Yet those who have devoted much study to the Samian ware discovered in Britain are inclined to attribute no later than from A.D. 100 to 150 to a very large proportion of the examples discovered in the Roman levels of London.

Site of the New Discoveries.

Some months ago a building was taken down on the east side of King Street, Cheapside (Nos. 7 and 8), and the excavations for the new structure were carried down to the undisturbed gravel or ballast which covers the central area of London. Through the kindness of the Atlas Insurance Company, the owners of the site, I was given ample opportunities for examining the ground during the removal of the ancient layers of disturbed soil which lay beneath the recent foundations. Usually the modern methods of excavation make it extremely difficult for the archaeologist to examine the deposits at all carefully, but, by good fortune, a large section, about four feet in depth, was exposed down to the gravel when work ceased on a Saturday morning. There was thus a week-end during which I was free to investigate.

The vertical surface which the spade had exposed is shown in the accompanying diagram. It will be seen that, counting from the virgin soil, there are seven definite and well-marked occupation strata surmounted by an eighth showing irregularity, and a series of burnt deposits superimposed closely on top of one another.

The lowest stratum rests upon the virgin gravel soil, in which there were indications of growing trees, bushes, and herbage. Its thickness varied from ten to twenty inches, but the surface being irregular, it may be described as of an average of a foot. Where the section was made there appear to have been two shallow trenches, but a few feet to the south the surface seemed fairly level. In this layer, in places resting on the virgin soil, were two fragments of rude hand-made native grey ware; a few bones of animals—one of them showing evidence of having been cut with a sharp instrument; two grooved handles of pitchers or flagons of definite Roman

*

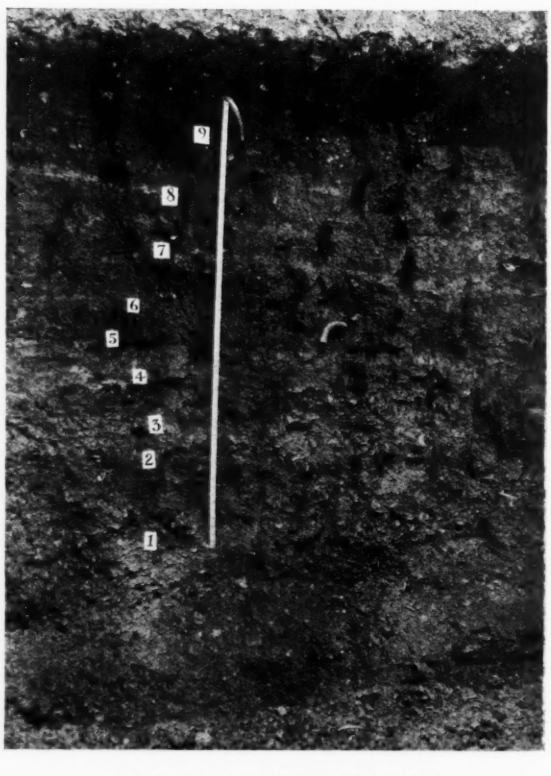
first century type; parts of the base of a similar vessel, and numerous fragments of well-finished grey ware with a pale red surface. In addition, much of it resting on the primitive surface, was a quantity of Samian. This and all the other fragments have been submitted to Dr. T. Davies Pryce, who identifies it as Flavian or pre-Flavian, that is, prior to A.D. 96. One Samian base of a cup of No. 27 form, bearing the stamp of the La Graufesenque potter Murranus repeated three times—an unusual feature—is attributed to the period Claudius to Nero, *e.g.*, A.D. 41-68. Another cup of the same type (absolutely plain) bearing the stamp (as far as it can be read) PRIM appears to be from the well-known La Graufesenque factory of Primus, which apparently began to work very early in the first century A.D. This may be pre-Claudian. There is a plate (form 15-17), attributed to a pre-Flavian date, and another of a type found at Mainz and Silchester belonging to the period from Claudius to Vespasian. Besides these there is a small cup (form 24-25) which may be either Arretine (from Arretium in Italy) or early La Graufesenque. It is perhaps the earliest type of Samian ware found on the site, and from the point of view of its glaze is similar to the cup stamped PRIM just mentioned. In this connexion it seems to be generally agreed that the form of this cup belongs to the period of Augustus, and it is therefore quite probable that this little vessel was imported into Britain before the Claudian conquest. There is some reason to believe that various master potters of Puteoli in Italy transferred their activities or established branches in South Gaul. Oswald and Pryce* are inclined to think that Primus was one of the potters who may be included in this category.

Besides these two cups there was found by a workman part of a decorated Samian bowl (form 29) at about the same level on the other side of the site, but approximately a foot above the original undisturbed gravel and therefore possibly above the level of occupation marked 2 on the sectional drawing. It is of a type generally classed as Claudian or possibly Tiberian, that is to say, from A.D. 14 to 54. The decoration is devoid of human or animal forms, the upper frieze having an undulating and spiral design and the lower a regular gadroon or elongated tongue fluting. With much probability this may be attributed to at least the earliest La Graufesenque potters—possibly Bilicatus or Scottius.

In addition to all the objects already mentioned, the lowest level yielded an oyster shell, parts of large amphorae, and some interesting leather in a very good state of preservation. The skin was very thin and was made up in two thicknesses, and one edge was turned up to form a seam—the holes through which the thread was passed being still visible.

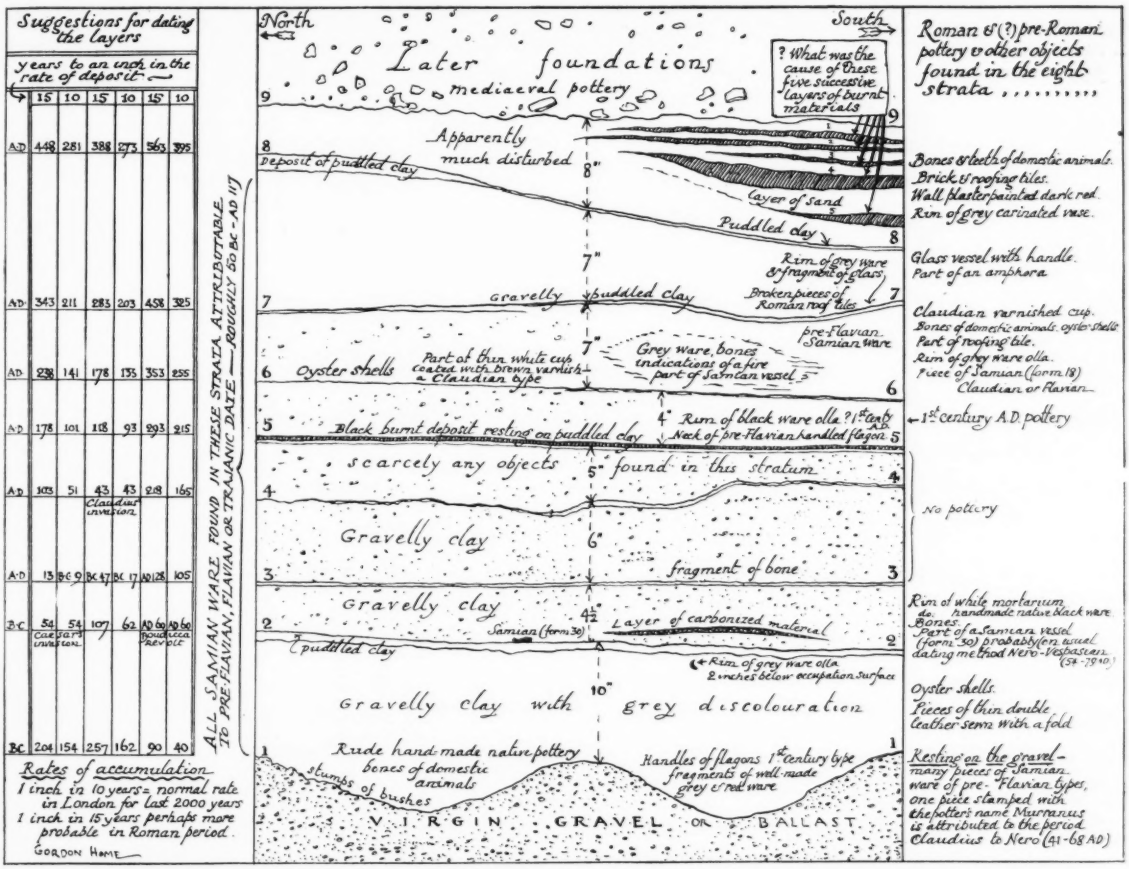
In level No. 2, the finds are somewhat scanty. They include a single fragment of Samian, tentatively dated to the period of Nero-Vespasian, A.D. 54 to 79 a small fragment of a white mortarium; two pieces of very rough hand-made grey ware; and two bones of domestic animals.

Practically nothing was found in level No. 3, and the same applies to No. 4. In No. 5 were unearthed the neck of a pitcher of biscuit-coloured ware, attributed by Dr. Pryce to a pre-Flavian date, and a piece of wheel-made grey ware of rather primitive type, with a slightly ornamented band near the neck. Layer 6 contained a number of pieces of rough grey pottery of various types. They were apparently upon a hearth, together with bones and two pieces of Samian pottery. One of the latter was a cup (form 24-25) of a type regarded as Claudian, and not far away was a fragment of thin whitish-coloured ware



ACTUAL VIEW OF THE SITE EXCAVATED.
A fifty-inch tape measure is placed beside the numbers which indicate the layers shown in the diagram opposite.

* *Terra Sigillata* pp. 9 and 10.



A SECTION OF THE LOWEST LEVELS OF LONDON RECENTLY EXPOSED AT 7-8, KING STREET, CHEAPSIDE.

The virgin soil was eighteen feet below the present street level and the seven strata resting upon it, forming a total thickness of deposit of over four feet, contained no pottery attributed to a later date than the reign of Trajan (early in the second century). In the stratum above level 9 was found much mediaeval pottery. The problem raised can be considered in conjunction with the suggestion for dating in the columns on the left.

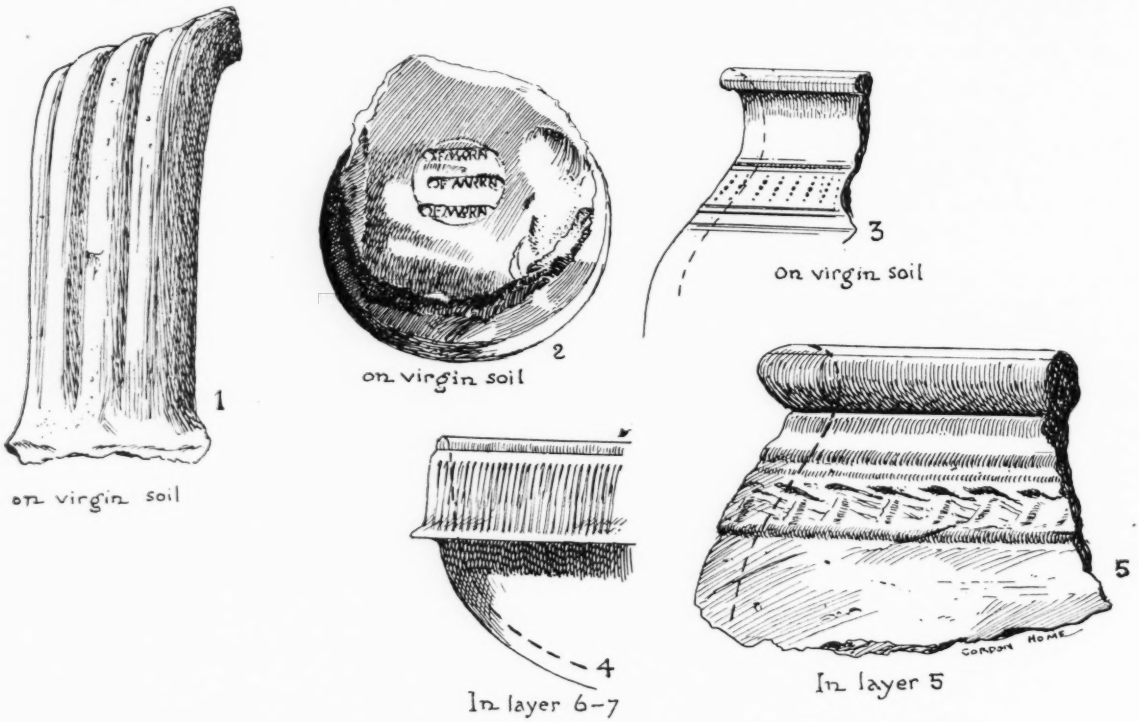
coated on both sides with an umber varnish dusted with white particles. Dr. Pryce recognizes this as part of a small basin of Claudian type which has occurred elsewhere in London, at Richborough and Silchester, and also in Hofheim I. This was the first level in which roofing tiles were found. Oyster shells and bones—many of sheep—were also brought to light.

On layer No. 7 there turned up two pieces of very coarse grey pottery; a few fragments of finer cream-coloured ware; part of the flanged-edge of a roofing tile which shows signs of burning; two fragments of a handled jug of whitish ware, attributed to the Flavian epoch; a fragment of bone; and lastly a few pieces of Samian ware. These last include a vessel (form 15-17), regarded as Flavian; part of a base of Trajanic date, and another fragment of a cup (form 27) of a shape slightly different from any illustrated by Oswald and Pryce.

Between this layer and the irregular upper deposit occurred more building materials in the form of roofing tile, brick, and wall-plaster painted dark red. Samian was represented by a tiny fragment, too small to recognize its type. There were three or four varieties of grey and dull red ware and part of a large heavy vessel of the amphora type. One piece of pale red ware, with a cream-coloured outer coating was, in Dr. Pryce's opinion, of first century date. A few fragments of small bones and teeth, which I have not yet identified, and the neck of a glass bottle with the common type of fluted handle, complete the whole of the discoveries which I made in the layers shown in the diagram. Above the stratum 8 to 9 there were confused foundations of later periods in which were found many examples of mediaeval pottery.

I now come to the interesting problem presented by these finds. There are in all seven well-defined

occupation levels numbered from 2 to 8 in the section, and above No. 8 five irregular deposits in a thickness of from eight to ten inches. My opinion that the level in other parts of the site, another black deposit of burnt materials was plainly visible. Slight indications of a fire occurred above level 6, and above



EXAMPLES OF THE EARLY POTTERY FOUND IN THE WIDELY SEPARATED STRATA EXCAVATED.

1. Handle of a first century white ware flagon. 2. Base of Samian cup (form 27) stamped MVRRAN[VS] a La Graufesenque potter of the period Claudius to Nero. 3 and 5, Grey and black examples of first century pottery. 4. Samian cup (form 24-25) of pre-Flavian date (i.e. prior to A.D. 69).

layers represented distinct periods of occupation was endorsed by Dr. Mortimer Wheeler, Keeper of the London Museum, who visited the site at my suggestion, when a portion of the section was made visible.

The virgin soil lies at an average depth of eighteen feet below the present street level, and the total thickness of the eight deposits with which we are concerned is four feet three and a half inches. It is generally taken that the rate of accumulation in central London is about one foot per century, and this seems fairly well supported by the total depth just mentioned, which is the average within the city walls. On this basis, and supposing that at first the rate of accumulation was comparatively tardy, the eight layers represent a period of hardly less than four centuries. One might legitimately regard it as longer, especially in view of the irregularity above surface No. 8.

It should be noticed that on top of surface No. 2 there was a deposit of carbonized material, and right across No. 5, extending to wherever I noticed the level 8 were five separate indications of fires one above the other.

It will be seen that throughout the series pottery has been found attributed approximately to the period A.D. 1 to 110. No single fragment has been recognized as belonging to a later date, and yet the depth of the deposits is over four feet. One would naturally expect to find Samian ware of all periods in the four or five lower levels, and above a gradual disappearance in favour of the native British manufactures—those of Castor, the New Forest, and elsewhere—but instead of this one is presented with the somewhat astonishing fact that, as high as the seventh layer, Samian ware of a comparatively early date continues without a single example belonging to the post-Trajanic epoch. Gallic Samian ware of the earliest type is found on the lowest level—I discovered it actually resting on the original ballast—and there are the examples I have already mentioned which may possibly belong to the first century B.C.

How can this anomaly be explained?

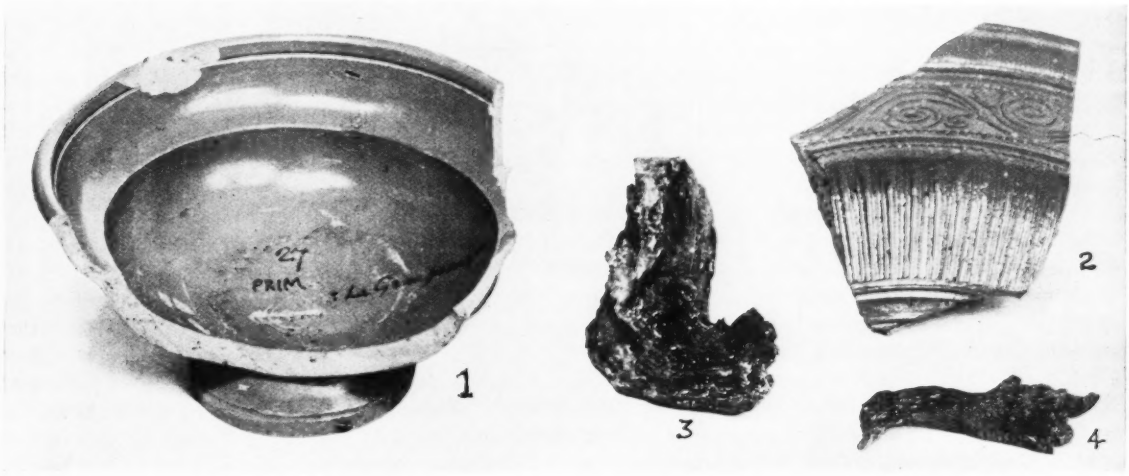
One might commence by suggesting that on this spot, a little to the west of the Walbrook, for reasons unknown, accumulation of soil proceeded at a rate enormously in excess of that elsewhere ; in fact, if it is to be supposed that layer No. 7 is of the Trajanic period, then the surface rose at the seemingly impossible rate of about an inch during two and a half years, or three feet seven and a half inches in one hundred and ten years ! Such a speed in building up archaeological deposits in the conditions which London presents seems impossible.

It might be put forward (1) that there was a hollow at this spot which was subject to periodic flooding, resulting in a deposit of detritus, but the site offers no support to such a theory ; (2) that the place was used as an extensive rubbish heap and periodically covered over with a layer of earth. But the distribution of the finds is entirely opposed to such a hypothesis, and the stratification is generally horizontal ; (3) that the ground was often made up for successive rebuildings of houses in the immediate vicinity, so that it rose out of all proportion to the rest of the city. This seems to be the only explanation which can be regarded as having a shadow of rationality and yet, when examined closely, it appears as unsatisfying as any of the others.

It should be noted that, on the south side of the site, a roughly-built wall of chalk rubble stands on the virgin soil, that is, on the earliest habitation level. The absence of distinctively Roman features prevents one from attributing it to any particular builders, but the evidence of the level points to a very early date. A dilemma seems to be presented (1) either the accumulation of soil proceeded at an unheard of rate ; or (2) the four feet of deposit represents a period of four centuries, and in that case Samian pottery of the first century was used, and presumably manufactured in Londinium as late as the fifth.

In this connexion it is a fact not to be ignored that a mould for Samian pottery was found in London on the site of old St. Paul's, while parts of other moulds for Samian ware have come to light at York. If suitable clay for turning out a comparatively uniform production, as we know to be the case, was found at places so widely distributed as Puteoli, Arretium, La Graufesenque, Lezoux, Rheinzabern, and Westerndorf, is there any reason to deny the feasibility of potteries for the manufacture of Samian ware having been set up in Britain ?

Until much more work is done in London on the lines which I have indicated here, it will not be possible to make any confident deductions, but I would mention that Mr. Quinton Waddington, of the Guildhall Museum, is impressed with the fact that nearly all the Samian pottery which comes to his notice from the Roman levels of London is attributed by those who claim to be expert in the subject to approximately the same period as that of the King Street site here described. I confess that I am left wondering whether the dating of this pottery, as worked out by Dragendorff, Déchelette, and others, is quite accurate. If it be, there are obviously some highly interesting problems still to be worked out in regard to the accumulation of soil in Roman London.



TWO FURTHER SPECIMENS OF THE EARLY SAMIAN POTTERY DISCOVERED IN CHEAPSIDE.

1. Cup (form 27) of quite plain type bearing the potter's mark PRIM. 2. Part of a Samian bowl (form 29) found about occupation layer No. 2. It is of a type generally regarded as Claudian or Tiberian. 3 and 4. Stumps of bushes found on the natural surface.

The Total Eclipse of the Sun in June.

By W. J. S. Lockyer, M.A., Ph.D., F.R.A.S.

Director of the Norman Lockyer Observatory, Sidmouth.

Although some months have yet to pass before a total eclipse of the sun—the first visible in England since 1724—is again due, an advance description of what is to be looked for will suggest how the subject may best be studied in anticipation of the interesting event.

Our sun, as we see him daily, presents to the naked eye a brilliant disc of light with an extremely sharp edge or limb. With the aid of a telescope, using suitable precautions, this limb maintains its sharp nature, but sometimes it is seen broken up into small ripples, always on the move, caused by the air waves of our own atmosphere when the latter is unsteady or, in other words, when the "seeing" is not good.

It is only due to the occurrences of total solar eclipses, occasions when the moon comes exactly between us and the sun, and cuts off all the brilliant light of the disc, that there is revealed to us an outer solar atmosphere of an exquisite pearly hue known as the "corona." Without such eclipses this atmosphere, even with the aid of any of the great optical means available to-day, would still be unknown to us. This atmosphere is of very considerable extent, far exceeding in proportion to the size of the solar disc that of our own in relation to the size of the earth.

The exact height of our atmosphere is not known because its density, while decreasing very rapidly near the earth's surface, diminishes very much more slowly in the upper layers. The only method known of finding even an approximate value for the height of the upper limit has been gained from the knowledge of the appearance of meteors. The general conclusion adopted is that meteors rarely appear above 150 miles and seldom above 130 miles. If, however, we assume 200 miles as the height of the earth's atmosphere, then this value is only one fortieth of the earth's diameter.

An Unsolved Problem.

Now the sun's atmosphere is on a far grander scale than this. It is seldom smaller than the diameter (866,000 miles) of the sun, and sometimes in regions has reached to a height of six times the solar diameter, or a distance of a little over five millions of miles from the sun's limb. What is the nature of this atmosphere is quite unknown to-day. That it is due to gas or gases of extreme tenuity is self-evident, but what their composition is has up to the present baffled all attempts of astronomers to unravel.

The study of the sun both in and out of eclipses, with various instruments of most ingenious design, has so advanced our knowledge that to-day the work to be done when the sun is totally eclipsed is very much restricted. Thus the observation of both the forms and chemical nature of the prominences can now be made any day when the sun shines, and the spectrum of the chromosphere* is so well known, except perhaps for the red end of the spectrum, that its study is not of such prime importance as it was. The chief work is now confined to the study of the form and composition of the corona, and these are the main objects for which eclipse expeditions are sent out.

Where to see the Eclipse.

On 29th June this year a total eclipse takes place, and the central line of totality passes across the British Isles for the first time for no less a period than 203 years. The central portion of the track is restricted to the north of England, passing through Criccieth (Carnarvonshire), Colwyn Bay, Southport, and it leaves the coast a little to the north of Hartlepool. The duration of the total phase will vary from about 22 seconds at Criccieth to about 24.5 seconds at Hartlepool, and will be sufficiently long for anyone to enjoy thoroughly the observation of such a magnificent and awe-inspiring spectacle, and also to carry out useful work with appropriate instrumental equipment.

Unfortunately the eclipse, as seen from this country, takes place in the early morning about 5 h. 24 m. Greenwich Mean Time, or 6 h. 24 m. British Summer Time, so that the sun is very low over the north-eastern horizon, being about eleven degrees in altitude. Farther along the track in Norway the sun will be higher, and the conditions more suitable for those who intend to work with powerful apparatus. At all places within about fifteen miles on each side of the central track the eclipse will be total, but its duration decreases rapidly as the central line is departed from. Outside this belt the eclipse becomes partial, and all the grandeur of the phenomenon will be lost.

* The chromosphere is the solar layer from which the prominences arise.

It is well known that the form of the corona varies very considerably, and it is interesting to inquire what shape the corona of next year will take. Sometimes the form is very irregular, the coronal material being extensively distributed all round the solar disc, embracing both the solar poles and the equator. This form is termed the "polar" type, as coronal streamers are situated near the solar poles (Fig. 1).

On other occasions the polar regions are rendered very conspicuous by the complete absence of streamers, and in their place beautifully curved rifts or plumes are seen, the long streamers being restricted to the equatorial regions. This type of corona is termed "equatorial," and is sometimes referred to as a "windvane" form, as it rather resembles this object.

Lastly, there is a third and also very pronounced shape which is intermediate between the above two forms. This is termed the "intermediate" type or "square" corona. In this case the streamers are generally concentrated in mid-solar latitudes, leaving the poles and equator comparatively free from any large coronal extensions.

The question arises: What will be the shape of the 1927 corona? Will it be of the polar, intermediate or equatorial form?

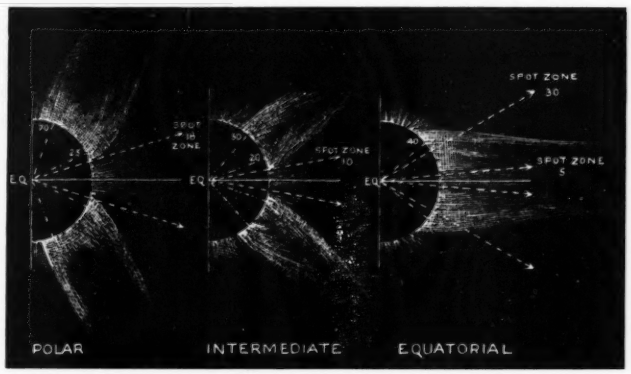


FIG. 1.
WHAT WILL BE THE SHAPE OF THE 1927 CORONA?
Diagram illustrating the three chief forms which the outer solar atmosphere, the corona, may assume, and showing also the mean positions of the sunspot zones (long radial lines) and prominence zones (short radial lines).

Before answering this it is necessary to refer briefly to the previous history of the records of solar activity. It is well known that the number (or area) of the spots* on the sun varies from year to year, and that about every eleven years or so this number reaches a maximum value. This cyclical change of spotted area is shown at the top of Fig. 2. Sunspots are not formed on any part of the solar disc, but are strictly confined to a belt which lies approximately between latitudes 45 degrees and 5 degrees on both sides of the equator (see Fig. 1). Sunspots therefore never occur at or near the solar poles. The mean yearly positions of these belts are shown in the third series of curves illustrated in Fig. 2. The latitudes of sunspots are closely associated with sunspot frequency. When there are most spots their mean latitude is about 18 degrees; when there are fewest spots their mean yearly latitudes are about 22 degrees and 8 degrees. The formation of high latitude spots near a sunspot minimum heralds the commencement of a new cycle of spotted activity.

In the case of solar prominences their appearance waxes and wanes very closely with the sunspots, as is indicated in the second curve (Fig. 2). When there are numerous spots there are many prominences and vice versa. There is, however, a very big difference between their behaviour as regards solar latitude. Prominences can occur in any part of the sun, and they can be as large and conspicuous at the poles as they may be at the equator. When they are at their maximum frequency they occur in two zones, the mean yearly latitudes of which are about 70 degrees and 25 degrees. When they are fewest in number their mean yearly latitude is about 40 degrees. This cyclical change of latitude from year to year is illustrated in the fourth series of curves (Fig. 2).

It should be noted that while the epochs of sunspot and prominence maxima are practically coincident, the spots at these times are most active in a mean latitude of 18 degrees, while the prominences exhibit their greatest activity in mean solar latitudes of 70 degrees and 25 degrees.

Turning attention now to the various forms of the corona as recorded by eclipse observers since the time that routine prominence observations first began, namely, the year 1872, it is found that these forms recur in a cyclical order. If, for instance, all the forms termed "polar" be placed in the horizontal strip near the bottom of Fig. 2 in their respective years of observation according to the time-scale of years indicated at the bottom of the diagram, and all those designated "intermediate" and "equatorial" also placed in lower strips at their observed dates, it will be found that a curve can be drawn through them closely resembling the sunspot and prominence curves shown at the top of the figure. It will be seen that the forms of the corona follow one another in the

* Phenomena in the solar atmosphere (comparable to tornadoes on the earth) due to falling cool material and visible owing to the comparatively dark clouds that are formed.

order polar, intermediate, equatorial, intermediate, polar, etc.

Comparing these forms with the prominence curves immediately above them, particular attention should be drawn to the fact that in those years when the coronal form is "polar" it is in those same years that the prominences are situated at or near their highest solar latitudes. In other words, when prominences are near the solar poles it is only at those times that coronal streamers are found there. This fact points clearly to the conclusion that prominences are the cause of coronal streamers. There is other evidence to permit one to associate prominences with coronal forms such as, for instance, the arch-form of coronal matter so often recorded as being directly situated over a large prominence, in spite of the fact that the material of which prominences are made of is perfectly distinct from that which composes coronal matter.

A closer study of the coronal forms with the curves of prominence latitudes suggests an explanation of the different forms observed. Thus the "intermediate" or "square" type of corona probably originates from the fact that when this form occurs there are two zones of prominence activity in each hemisphere. Again, in the case of the "equatorial" or "windvane" type there is only one zone of prominence activity in each hemisphere.

The forecasting of the form of the corona for this year therefore resolves itself into the problem of forecasting the latitudes of the prominences for that year.

Now up to the year 1924 all the facts of observation are recorded in Fig. 2, and these are represented by *continuous* lines. It will be seen that each set of curves has its own particular rhythm, and by reproducing this rhythm the curves can be extended. The *dotted* portions of the curves represent their extensions up to the year 1940, and indicate in an approximate manner what may be expected to occur in the light of past experience. The forms of the corona for the eclipses 1925, 24th January, and 1926, 14th January, have already been observed to be of the "intermediate" type, and conform to the form expected from the dotted prominence curves.

It is to be expected that the sunspot and prominence curves will reach a maximum in the year 1928. In 1927, therefore, the prominences will be nearly at their maximum frequency, and their more northern zones will be approaching the polar regions reaching about latitudes 70 degrees.

Thus it follows that the corona of next year should take the "polar" form, and it follows the two "intermediate" types mentioned above preserving the natural sequence.

From the diagram (Fig. 2) it will be seen that not only can one make a very fair estimate of the form of the corona for next year, but good approximations may be formed for some of the other eclipses to come.

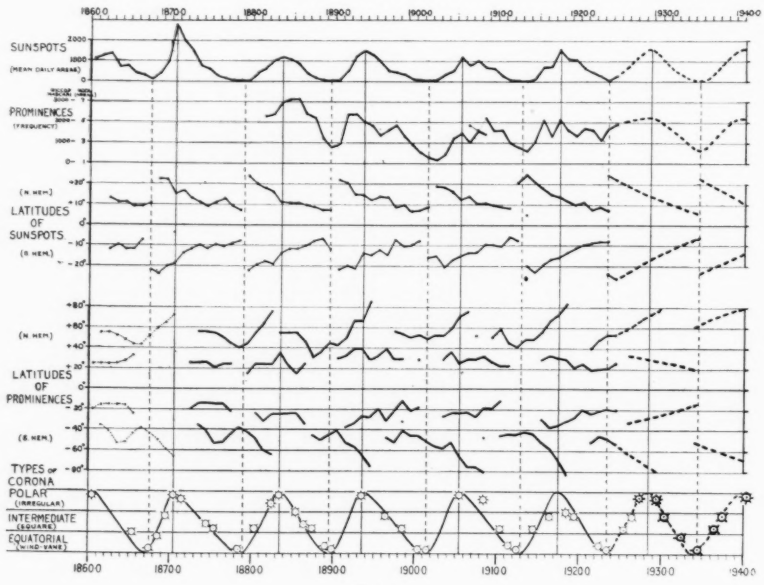


FIG. 2.

PAST OBSERVATIONS AND WHAT MAY BE EXPECTED IN FUTURE ECLIPSES.

Chart showing the variations (continuous curves) of the activities of sunspots and prominences from year to year with their corresponding zones (latitudes) of activity, together with the recorded forms of the corona. The broken curves represent the "forecasted" observations, and at the bottom of the diagram the "anticipated" forms of the corona for future eclipses up to the year 1940.

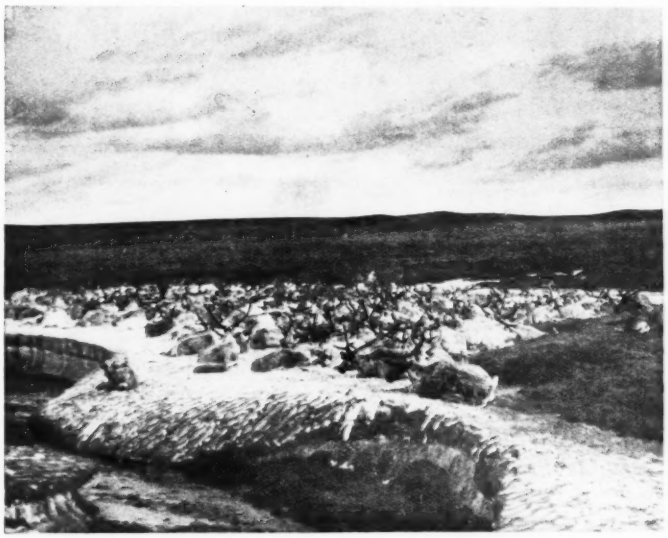
The "polar" type of corona is always the most interesting to observe, because it occurs when the sun is near or at its greatest activity. The large number of spots and prominences, signs of violent solar outbursts, renders the corona much brighter and more extensive than at other times. This condition is specially waited for by those who wish to study the nature of the corona by means of spectroscopes, for many of the lines in the spectrum are faint and require a bright image for the successful record of them.

The Samoyedes of the Siberian Tundra.

By Maud D. Haviland.

Following a tour through the Siberian tundras, the author describes their scattered inhabitants, the Samoyede tribes, whose affinities are not yet altogether understood. Interesting modifications in the customs of these primitive peoples have resulted from contact with Russian settlers.

FIVE hundred years ago Marco Polo, travelling through the then unknown regions of Central Asia, learned by hearsay of a yet more distant and desolate wilderness to the northward, "a land inaccessible because of its quagmires and ice." This is the first mention of the great Siberian tundras, but in the ensuing centuries little more has been heard of them and their inhabitants. Herein the arctic forests and plains of Eurasia differ from those of the New World which have formed the setting for a whole cycle of tales of redskin and Esquimaux. But no Nainuk nor Chingachgook has hunted in Siberia; and consequently many of us who might discourse with understanding of igloes, pemmican, and wampun, have never heard of chums, souhkari, sakhui, and the rest of the domestic amenities of the wandering Samoyede.



HERD OF REINDEER RESTING ON A SNOWDRIFT.
Reindeer herding, the most primitive, is still the most important tundra industry.

It must be admitted indeed that this was the position of the writer, until chance, some summers back, sent her for four months on the Yenisei tundras as one of the party of the late Miss M. A. Czaplicka of Oxford, whose short life was devoted to her brilliant researches into the Samoyedic and Tungusic tribes of Siberia.

The tundras of the Samoyedes stretch eastwards from the Ural Mountains across the estuaries of the Ob and Yenisei Rivers and the Taimyr Peninsula to the Khatanga River. The scattered and nomadic population is divided into several races whose affinities are not yet altogether understood, and who often speak different languages and have different customs. Thus along the Yenisei, the middle forested reaches of the river are occupied by Tungus tribes, and by the remnant of the once powerful Ostyak race; and the tundras of the great estuary are inhabited by three peoples—Samoyedes, Yuraks, and Dolgans. The Samoyedes *sensu stricto* live on the right bank of the river as far east as the Khatanga. The southern limits of their hunting grounds overlap those of the Dolgans, a tribe whose affinities lie with the Tungus and Yakuts of the forest region. West of the Yenisei are found the Yuraks, who speak dialects of the Samoyede tongue. These tribes are all reindeer-herds, hunters, and fishermen, but although they live peaceably with one another, and may even intermarry, they differ somewhat in their customs. For instance, the Dolgans, like the Yakuts of the Lena Basin, are comparatively recent comers to the far north, and they have brought with them certain customs of their steppe-land ancestors. They not only drive reindeer in sledges, but ride them also like horses, a custom which the Samoyedes have never acquired. They also have a Tartar-like love of bright colours, and their caps and *sakhui* (a hooded cape of felt or deerskin) are often beautifully embroidered with beads.

Naturally, contact with the Russian settlers has influenced the natives profoundly, and not for their good. Under the Tsarist government the aborigines were regarded as wards of the Empire, and protected to some extent by legislation; but where the distances were so vast and the population was so scattered,

*

the law was easily evaded, and the native was readily exploited by unscrupulous traders and prospectors. Apart from disease and the habit of drink, the Samoyede in contact with the settlements has learned other civilized usages, and in nothing is the impact of cultures more marked than in the use of boats. The philologist Kai Donner has remarked that the Samoyedes have no word for "sea," and in a land where all water is frozen like a rock for eight or nine months of the year, there is little inducement to the people to become sailors. The original native boat of the tundra seems to be a light bark canoe such as can be carried on a reindeer sledge. It is used for crossing rivers when on a journey and for goose hunting on the lakes. But nowadays certain families contract to work in the summer as fishermen for some Russian merchant, and in such cases a clumsy wooden boat of European type is used. The natives become quite expert oarsmen, but it is interesting to find that they have already begun to modify the alien culture that they have adopted. With their slight physique they are unable to wield the long narrow-bladed European oar, and to combine the requisite leverage with lightness, they have evolved a short spade-bladed oar which is worked with both hands.

A TEAM OF REINDEER HARNESSED TO A SLEDGE.
When travelling each animal is attached separately to the frontal bar of the sledge by a trace which passes round the neck and back and between the forelegs.

Only the poorer natives thus hire themselves out to the Russians. Usually it is a family which has fallen into debt with a trader, or has lost all the reindeer through disease. The wealthier Samoyedes, who may own many hundreds of deer, seldom come near the settlements except to trade, but spend the summer roaming over the remoter tundras up to the shores of the arctic sea. In that barren land the grazing herds require wide pastures to provide them with enough of the short scant lichen, *Cladonia rangiferina*, which is the principal food of the reindeer. In the Lapp countries of Europe it is a recognized economic fact that 4.44 square miles per annum must be allowed for every head in the herd.

Reindeer herding, the most primitive, is still the most important tundra industry, and it is not too much to say that without it the "Big Low Tundra" from Khatanga Bay westward would be impossible for human habitation. The whole annual cycle of the Samoyede hinges upon that of his deer. In spring, when the days lengthen, the family leave their winter quarters on the fringe of the forest where fuel is to be had. The winter *chum* (tent) is left standing with all the unnecessary household gear, for in that primitive society theft and pillage are almost unknown. The trek to the summer quarters in the north may take more than two months and extend over five hundred miles. In May the thaw sets in; and when the floods have abated at the end of June, the reindeer are driven up to the higher ground, away from the river swamps which at that season are so infested with mosquitoes that life there is almost impossible to man and beast. In summer the deer's antlers are in velvet and the animals are in poor condition so that they cannot be driven more than fifteen or twenty miles in the day, and indeed the natives are loath to move them at all.

The summer camp with its perpetual daylight and comparative warmth is a picnic to the Samoyede after the months of frost and darkness that he has just passed through, when the *purga* (blizzard) rages outside the tent, and life in tundra and forest is at a standstill. In summer food is fairly plentiful—on the way north he has found opportunity to barter his winter's catch of foxskins to some trader in exchange for tea, tobacco, felt (for clothing), and *soukhari*, which is Russian bread dried to hard biscuit-like consistency in the oven. His wants are few. From a bit of driftwood from the river beach, or from a piece of semi-fossil mammoth ivory, he can fashion nearly everything he needs with his own knife. And this very knife he often grinds for himself from an old kettle or other scrap-iron which he has obtained

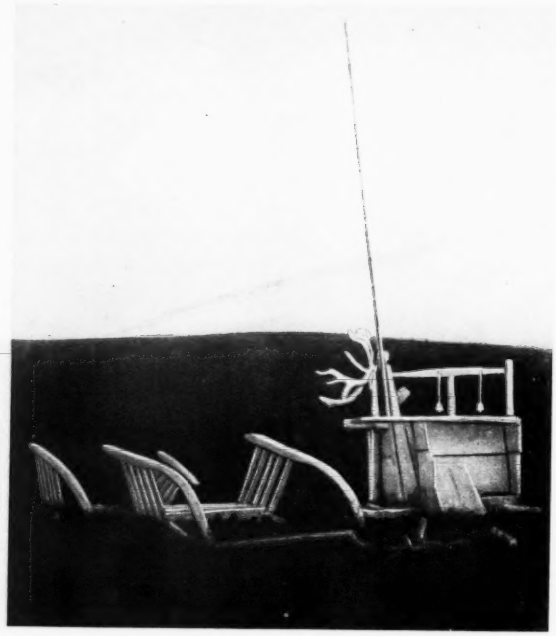
SAMOYEDES FISHING WITH A RUSSIAN BOAT.
With their slight physique the Samoyedes are unable to wield the long European oar, and they have evolved a short spade-bladed type.

from some settlement. The green dwarf willow of the tundra slopes supplies his modest needs in fuel, and twisted reindeer sinew provides twine and sewing thread if he requires them. The deer browse leisurely round the camp, rounded up occasionally with the help of the small furry prick-eared dogs which share the *chum*; there are now and then fishing or goose-hunting expeditions to the lakes; harness and tents and sledges are repaired, and altogether the time passes pleasantly until mid-August, when the return of night and an occasional frost warns of the approach of winter. Then, before the weather has broken up in gales and rain at the end of the month, the sledges are packed and the long journey back to the forest border begins. Each sledge is drawn by a team of four deer, attached separately to the frontal bar by a trace which passes round the neck and back between the forelegs. The deer are guided by a rein round the antlers of the outermost animal, which is pulled sharply to right or left, and by a long wand carried by the driver. Besides several store sledges, each family travels with a canoe on a spare sledge, and when a river is encountered, the sledges are unloaded and the passengers and the goods are laboriously ferried over one by one in the frail craft. The deer are then driven into the water and swim across, towing the sledges behind them.

It is a constant source of wonder to the European traveller that the natives can find their way so unerringly over what appears to be a trackless waste of bog-moss and lichen, where there is neither road nor hill nor tree to provide a landmark. The monotonous undulating land fades into the cloudy distance for mile after mile; and just as in that season of perpetual daylight time seems to stand still and to be of no account, so in that country of vast empty spaces distance seem to be endless, and direction a matter of no importance. And yet the Samoyede is able to guide his little team over the waste with as much precision as a London taxi-driver taking a fare from Westminster to Hampstead. This knowledge of the country is due, of course, partly to a highly-cultivated power of observation and partly to experience, but it is difficult to attribute it altogether to these, for even the children are able to take long journeys unattended over unknown country, and a knife or cap accidentally dropped many versts from the camp is always recovered. It is a curious fact that the reindeer themselves have no homing instinct, and although domestic deer will run to a *chum* for shelter in a storm, even though it be many miles away, they show no discrimination and will seek out a strange camp as readily as their own. For this reason some of the Russian traders on the Yenisei prefer to use dog sledges, as they can rely on the sagacity of the dogs to bring them home when lost out on the tundra.

In addition to reindeer herding and fishing, the Samoyedes are hunters and trappers. Wild reindeer are occasionally hunted by parties of men who set up two lines of posts, surmounted by the outspread

A GROUP OF NATIVES CLEARING THEIR NETS.
The Samoyedes are not sailors by inclination, since water is frozen for eight months of the year, and their language has no word for "sea."



THE GRAVE OF A YURAK, ONE OF THE SAMOYEDE TRIBESMEN.
The body is buried above the ground in a wooden case, and on this are hung little bells which are believed to frighten away evil spirits. The dead man's sledge, driving pole, and reindeer's antlers are placed around the grave.

wings of wild geese and converging on to a lake or river. The hunters round up the deer into the *cul-de-sac* and slaughter them there. Another method employed in winter is for a single hunter who lies down behind a wooden screen on runners, covered with snow and drawn by a tame reindeer, which approaches the herd unsuspected.

Foxes are usually taken in traps of the deadfall type. A heavy log is set longitudinally between palisades of stakes and supported by a trigger to which the bait is attached. The fox enters the palisade to tug at the bait, and is then crushed by the falling log. In summer the Samoyedes go goose-hunting. As is well known, geese, unlike most other birds, moult their flight-feathers all at once, and for a week or two are unable to fly. At these times the natives visit the breeding grounds beside the tundra lakes and swamps and have grand battues, knocking over the helpless birds as they run to the water, and pursuing them over the lake in canoes.

By religion the Samoyedes are shamanists, but in the years preceding the war the Russian authorities were at considerable pains to convert them to the Orthodox Church. As a gratuity was offered to those who presented themselves for baptism, their evangelization met with a fair measure of success—on paper at any rate ; but the visits of the *batyushka* in that vast country were few and far between, and ancient practices and beliefs died hard, so that it is not surprising that in the dark of the *chums* of even the most civilized of the tribes the shamanistic images lay side by side with the Russian ikons, and were equally honoured. In the fishing stations, if there was sickness in a *chum*, the shaman was secretly called in on behalf of the patient ; and it was both weird and impressive in the strange light of the arctic summer night to hear the monotonous muffled booming of the shaman's drum. But the sound instantly ceased if Europeans were seen approaching the camp, for the natives were afraid that the shamanistic practices would be betrayed to the Russians, by whom they were regarded as illegal.

When a Samoyede dies, his body is placed upon his sledge and drawn out to a distance from the camp. Often a mud bluff above one of the river valleys is chosen. Here the corpse is buried in a wooden case or ark above ground, for nothing short of dynamite could blast a tomb in the frost-bound subsoil, and his possessions, his knife, his furs, his pipe, etc., are placed around it. Reindeer are often slaughtered beside the grave, and the sledge is left there with them. These little lonely graves, dotted about the tundra, are very touching. The natives avoid them, and when on a journey will often go some distance out of their way rather than pass by them closely. They believe that they are haunted by evil spirits, and the Yuraks go so far as to hang little bells on the graves of their friends that the tinkling may scare away the bad spirits which would otherwise molest the soul of the dead man.

Rapid Broadcast Pictures.

A PROCESS for broadcasting pictures that is claimed to be sixty times as rapid as by any other apparatus of the kind is reported from Norway, where Mr. Hermod Petersen, engineer at the Telegraph Department in Oslo, has recently made successful experiments. According to *World-Radio*, the supplement to the official organ of the B.B.C., the minimum speed of transmissions is 125 square centimetres a minute by this invention, which embodies the use of electric sparks on the receiver, for perforating it, the picture being produced by passing a coloured roll over the perforated forms. The cost is expected to be about £20 for each private apparatus, and among the advantages promised is that a lecturer may bring his illustrations to the wireless studio, so that these may be broadcast simultaneously with the address.

Problems of Research on Adhesives.

A New Government Report.

During this month an exhibit illustrating the official research now in progress on adhesive substances may be viewed in London. The notes printed below, available in connexion with the exhibit at the Science Museum, not only afford an interesting summary of this important branch of industrial research, but are an admirable example of what a report designed for popular interest should be.

By way of introduction, it should be stated that the exhibit in connexion with which these notes are published deals with the work of the Adhesives Research Committee of the Department of Scientific and Industrial Research, and is the result of a decision by the authorities of the Science Museum, South Kensington, to make available facilities for temporary public demonstrations of the progress and discoveries of current scientific investigation. While the following has been prepared to give some idea of the importance and scope of the problems dealt with, it should be noted that arrangements have been made by the department whereby British firms interested in the manufacture or use of adhesives, and in the treatment of fish residues to produce gelatin and other products, may by payment of a subscription be kept closely in touch with the work at present in progress.

The Scope of the Subject.

The most cursory review shows that the word "adhesives," as commonly applied, embraces substances of very diverse character and origin and which play in their individual applications an important part in manufacturing industries. Roughly classified there are, firstly, adhesives from raw material of animal origin, including :—

Gelatin adhesives (or "glues") from hides, bones, tendons and horn pith of mammals and from the skins and offal of fishes; casein adhesives from milk; blood cements from blood; and there may also be added shellac, which is derived from the secretion of the lac insect.

Secondly, adhesives from raw material of vegetable origin, which comprise :—

Gums, gum-resins, resins and oleoresins (or balsams) from the exudations of certain trees; starch adhesives from the grains and tubers of certain plants (notably maize and potatoes); and nitrocellulose adhesives from cellulose, the principal structural material of plants.

Finally, other adhesives of a miscellaneous character are :—

Cements in which silicates, glycerine, bitumen, waxes or synthetic resins play an important part.

Easily the most important from the industrial point of view is the group of products obtained from raw material of animal origin and, notably, the gelatin adhesives or glues.

Of the principal uses to which adhesives are put, probably the most commonly known is that of glue for joining timber parts. No less important is their use in the textile and paper industries as materials for sizing. They also find uses in other numerous directions; in fact, most of the manufacturing industries of this country may be said to be dependent to a greater or less extent on adhesives in some form or another. By way of illustration of the variety of their applications reference may be made to the use of glues, in addition to that mentioned above, in the preparation of paper boxes and cartons, bookbinding and labelling, in joining leather to leather, leather to metal, in the preparation of frosted glass, sandpapers and emery papers; to the use of shellac in the scientific instrument industry and the electrical industry, and as a binder in composition goods such as buttons, telephone receivers, and gramophone records; and to the use of Canada balsam in the optical instrument industry as an adhesive for optical systems. Taking in the same way other classes of adhesive products, the list of applications could be extended very considerably. Having regard therefore to the variety of the products, involving different processes of manufacture, and the variety of their applications under different conditions, it is clear that research on adhesives could absorb the energies of a considerable research organization. It is necessary for a small organization to confine itself to lines of inquiry which are likely to be of benefit in the use of adhesives in general, or to investigations dealing specifically with those adhesives which are of most importance in industry. The predominance of the gelatin adhesives gives them the first claim to attention on this latter footing.

Chemistry of Gelatin.

Although gelatin is the principal constituent of animal glues, knowledge of its chemical character is by no means commensurate with its industrial importance. With a knowledge of its composition, it should be possible to throw more light on the reasons for the variation in the adhesive power of glues: for instance, on the question as to how far the presence

or absence of various decomposition products, into which gelatin is readily broken up, affects the adhesive properties of glues. An adequate knowledge of the properties of gelatin is necessary for the proper study of the processes of manufacture of glues, and should lead the way to the production of uniform products. No less necessary, incidentally, is it from the point of view of the manufacturer of photographic sensitized materials. As is well known, the sensitive coating upon the plates, etc., used in photography consists of an emulsion of silver salts in gelatin. Very high grade gelatin, which is largely imported into this country from abroad, is required for the purpose, for the slightest variations have a very great effect on the results obtained. The photographic manufacturer at present makes an experimental emulsion to determine whether a gelatin is suitable for his purpose. Chemical and physical tests of the gelatin have not yet reached the stage of perfection that they can be relied upon without further test.

General researches on the chemistry of gelatin are being carried out on behalf of the committee by Professor S. B. Schryver at the Imperial College. The first aim of the work was the development of a method by which a standard gelatin having definite physical and chemical properties could invariably be produced, and it has resulted in the production of a very highly purified product. It is of interest to note that, contrary to views which have often been expressed, highly purified gelatin is not a poor adhesive ; it differs little in this respect from ordinary high quality glues. Methods of investigation are now being worked out which, it is hoped, will throw light on the composition of the highly purified product.

While it has no connexion with Professor Schryver's work on the chemistry of gelatin, it may be mentioned that in the committee's search for new raw materials, he has studied the possibility of obtaining adhesives from certain plant seeds, such as the castor bean.

Two types of adhesive material are prepared from fish. The first is isinglass, made from the swim bladder of the sturgeon, and the second is the ordinary fish glue usually prepared from fish skins.

Pure Isinglass Discovered.

Isinglass is an expensive material costing up to 36s a pound, whereas, for example, the best edible gelatin, which is a very good adhesive, is retailed at about 4s. a pound. While, therefore, isinglass is an adhesive of the highest quality, it is not commonly used as such except for special purposes, such as for leather belting. Perhaps its best-known use is for clarifying wines, beers, etc. Isinglass prepared from the swim bladders of fishes other than sturgeon has hitherto suffered from the disadvantage of having a disagreeable odour. In the course of work carried out for the committee under the direction of Dr. J. C. Kernot, however, it has been found possible to remove this disadvantage and to produce an isinglass from other fish equal in practical value to that obtained from sturgeon.

Taking now the ordinary fish glues, these have never enjoyed the high reputation of glue made from the hides, bones, etc., of land animals. One defect, apart from their smell, is that they absorb water easily. At the same time, there was no reason to suppose that glues of good quality could not possibly be obtained from fish. Moreover, the existence of a large fishing industry, providing considerable supplies of potential raw material for high-grade glue, emphasized the importance to this country of research into the improved production of fish glues, in view of the comparatively limited home supply of raw material of mammalian origin. The threatened shortage at the end of the war of available raw material for high-grade glues suitable for aircraft construction was, in fact, the reason for establishing the Adhesives Research Committee of the Conjoint Board of Scientific Societies, the predecessor of the present Committee.

Odourless Fish Glue.

In the course of the research carried out under Dr. Kernot, methods have been evolved for the production of odourless glue from fish, equal if not superior in adhesive power to the best glue obtainable from land animals. This glue has other important qualities. The use of glue and gelatin as emulsifying agents is well known. The new fish glue has superior qualities as an emulsifying agent. It has been found that it can effect emulsification without the addition of large quantities of soaps and/or caustic alkalis where such additions would be required to ordinary glue or gelatin. With it stable emulsions have been prepared of tar for roadmaking purposes, of tar oils and creosote for disinfectants, and of shale oil for preserving timber. The same process that produces this special quality glue from fish skins also yields improved products from other fish offal, though these latter products, as so far obtained, are distinctly inferior to those obtainable from fish skins. Another result of considerable practical interest which has emerged from this work is that fish skins, suitably treated, can be used as substitutes for isinglass in the clarification of beverages.

It may be noted that these researches have recently been extended by the Food Investigation Board of

the Department of Scientific and Industrial Research to include consideration of the improved production of fish meal and oils, which at present suffer in value on account of their " fishy " odour.

The use of glue in making timber joints which need to be of high strength—as, for example, in aircraft—makes it desirable to have some ready means of determining the adhesive power of the glue for timber. Some indication can be obtained from such physical properties as viscosity and " jelly " strength, and by chemical examination, but obviously the most satisfactory method of test is the direct one, in which the stress required to fracture an actual timber-glue joint test-piece is measured.

A Problem for Further Research.

Unfortunately, despite a considerable amount of work it is still the case that an entirely satisfactory form of test-piece does not exist. Large variations occur between the results obtained with the same glue, and this makes it necessary to make a large number of determinations in order to obtain anything like a representative value.

Not only does the absence of a suitable test-piece make it more difficult and uncertain to determine whether a glue comes up to specification, but it also hampers the development of improved glues of uniform quality. The scheme of work of the committee has therefore included a research on the mechanical testing of adhesives, which is carried out at the Royal Aircraft Establishment. In the course of this work, the causes of the variations in the joint strength values are being investigated, and a number of different types of test-piece, made with different kinds of wood, have been tried out. The " simple-lap " type test-piece appears to be the most satisfactory so far for comparative purposes, giving, with suitable timbers, fractures mainly in the glue, but the work cannot as yet be said to have approached finality.

The preceding investigations are of restricted application in that they deal with a particular, though the most important, group of adhesive products. There is, however, a field of inquiry which has a common bearing upon all adhesives, namely, that which is concerned with the factors underlying adhesion phenomena in general. These present some very striking features. It is found, for example, that soft and pliable wax-free shellac when interposed in the form of a thin film between, say, nickel surfaces, produces a joint capable of withstanding a stress of about two tons per square inch. No precise explanation of such phenomena can be advanced at present, though it is obvious that their elucidation might clear the way for important practical advances in the use of adhesives. It should help towards more direct solutions than are possible at present of everyday problems, as to the best adhesives in specified circumstances and the best conditions of use. It should also help in other related fields, such as, for example, the adhesion of lacquer enamels to metals, thus bearing directly on the lacquer industry which has developed so rapidly in recent years. A research into the nature of adhesion was therefore initiated by the committee, the supervision of it being undertaken by Professor J. W. McBain at Bristol University.

A wide survey is being made of the field of study by means of determinations of the strength of joints made with various materials, using a variety of substances as adhesives. The object of the survey was to bring out the salient factors, and valuable information has been collected. Certain generalizations are emerging as the result of the work to date. In the first place, there has been brought out the different character of joints with smooth surfaces, and joints with porous materials. In the former case (the " specific " joint) it seems probable that the joint is the result of some specific interaction between the adhesive and the material, but in the latter, the research has indicated that mechanical interlocking of the adhesive in the pores of the material would seem to be the main factor. Again in the case of the " specific " joint, the interesting fact has emerged that with many adhesives there is a parallelism between the joint strength and the physical and mechanical properties of the material joined.

Importance of Thin Films.

Incidentally, the observations made in the course of the experiments fully confirm general experience that " the thinner the film, the stronger the joint." It is pertinent, in this connexion, to mention that the study of adhesives in the form of thin films, which is a special feature of the work, is likely to prove a most useful addition to the technique of examining adhesives. Important information is being obtained thereby regarding their mechanical properties and the manner in which these may be modified to remove their limitations. As an example may be mentioned the utility of the technique in investigating that quality of adhesives which may be described by the term " deformability "—that is to say, the quality which enables an adhesive to adapt itself to changes of volume and shape on setting, ageing, swelling, etc. The value of an adhesive may be greatly impaired by inability to adjust itself to changes brought about in this way.

The Courtship of Spiders.

By Theodore H. Savory.

Many details in the courtship of spiders, which will repay further investigation, are here discussed by the author, whose new book on "British Spiders: Their Haunts and Habits" was reviewed in our December issue by Sir Arthur Shipley. Interesting discoveries have resulted from recent observations.

AMONG the many actions which spiders perform at different times in their lives, none is more curious than their habit of courtship before mating. Not only is the mere existence of acts of courtship indeed remarkable in itself, but there is a great diversity between the habits of the various families, coupled with difficulties in observing these activities, which results in the whole process being very little known.

Jumping Spiders.

In the matter of courtship one family of spiders stands supreme—the Salticidae, or family of jumping spiders. Our knowledge of their performances we owe to the patience and enthusiasm of Dr. and Mrs. Peckham, who have carefully studied the behaviour of many American species.

In the Salticidae eyesight is particularly keen, for these spiders hunt their prey and leap upon it from a distance. A second characteristic is that the males are often decorated with black or coloured patches on their legs or abdomen, secondary sexual differences which are not nearly so conspicuous in other families.

When a male jumping spider approaches a female, he executes a love-dance before her. He raises his front legs and waves them about, or he holds out the adorned legs of one side and walks round in a circle, or he raises his abdomen into the air. Whatever he does, he is performing a dance which is peculiar to his own species, and other species of spiders will dance in a different way. Moreover, it is to be noticed that the movements he makes are always such as will most conspicuously display his various colours; his dance looks just as if he knew exactly where his beauty lay and was determined to show it to his lady as clearly as possible. (Fig. 1 and 2).

She, for her part, takes an obvious interest in the proceedings. There is no doubt that she not only sees the charms that are offered her, but watches them intently, turning herself to keep the male always in full view. Sometimes she brings the business to an end by joining in the dance, the two spiders whirling round together.

It is clear that a complicated dance of this sort is of interest only to a spider endowed with good eyesight. None can see better than the jumping spiders, but some others, also huntsmen, can see fairly well. By far the most familiar of these are the Lycosidae or wolf spiders, the dark brown spiders which are so numerous in meadows and woods in the spring and autumn.

Some of the male wolf spiders have decorated legs, a few joints of which may be covered with thick black hairs, in distinct contrast to the rest of the spider.

The courtship of Lycosidae has recently been made the subject of a very able investigation by Mr. W. S. Bristowe and Mr. G. H. Locket. These spiders perform antics similar to those of the Salticidae, but apparently never so elaborate. The male usually contents himself with waving his palpal organs about in semaphore-like fashion, or he raises his forelegs quivering into the air, one after the other, while he takes a few steps, now to this side, now to that. (Fig. 3.)

An extremely interesting fact, which has emerged from these observations, is that the male wolf-spider is stimulated to begin his courting actions by the scent of the female. Whereas a male jumping spider was never seen by Dr. and Mrs. Peckham to dance until he had caught sight of a female, both Mr. Bristowe and Mr. Locket have witnessed a male wolf-spider performing his movements on being placed in a box which had previously contained a female, or on meeting some sand or water which had been shaken round her box. This has enabled these investigators to locate the scent-organs in the tips of the legs and palpi.

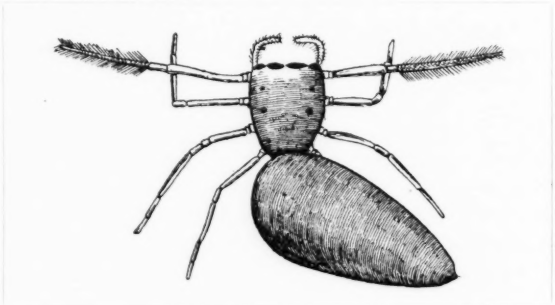


FIG. 1.
DISPLAY OF DECORATED FORELEGS BY A JUMPING SPIDER, *ICIUS MITRATUS* (AFTER PECKHAM).

The family Pisauridae is a not very distant relative to the true wolf-spiders, and is represented in Britain by two species, one of which, Pisaura mirabilis, is common everywhere. The courtship which this lady demands is a far more material business than the dances of the Lycosidae or Salticidae, for her suitor must wrap up a fly and present it for her acceptance. No dancing is to be seen. This is of interest, because biologists studying other groups have wondered to what degree an animal may be credibly supposed to possess a sense of the aesthetic and an ability to judge critically of the colours or the dance before her. There is very little of the aesthetic in a meal ready to be eaten. It is remarkable, too, that the carnivorous male should be willing to refrain from eating his gift

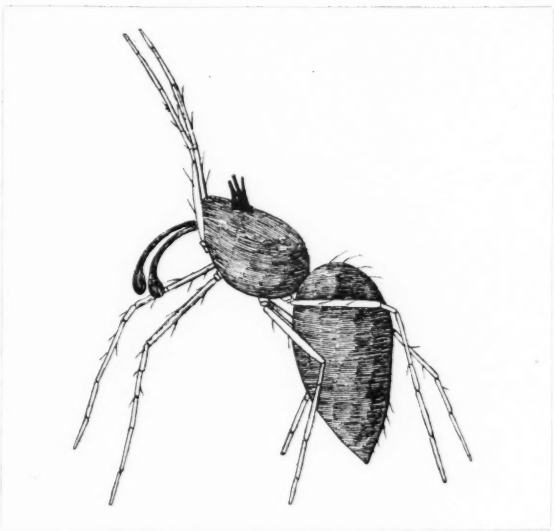


FIG. 2.
COURTING ATTITUDE OF THE JUMPING SPIDER, *ASTIA VITTATA* (AFTER PECKHAM).

himself, and Mr. Locket here interposes a truly delightful touch in the record of an offering by one male of a fly it had itself previously eaten !

There are other families of spiders which hunt their prey instead of ensnaring it in a web, and chief among these are the Thomisidae or crab spiders. These spiders owe their name to their habit of running sideways ; they generally spend their lives lurking in flowers or under fallen leaves or in similar situations, and darting upon the insects that approach them. Thus they are spiders with a certain power of vision. Further, we find among them many species in which the male has a different pattern from the female and is to some extent decorative.

Hence, although the sense of sight may not be very

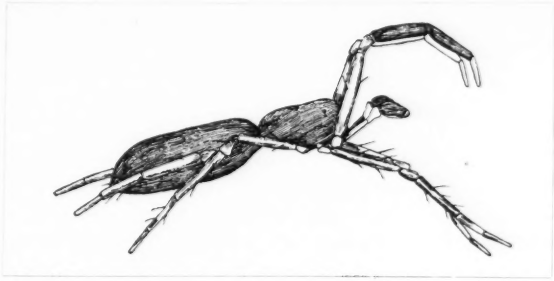


FIG. 3.
MALE WOLF-SPIDER DISPLAYING ORNAMENTAL FORELEGS BEFORE FEMALE (AFTER LOCKET).

keen, nor the masculine decorations extremely vivid, we might expect to find acts of courtship in this family. Mr. Bristowe has dealt a very efficient death-blow to such a hope. He has described how the male, recognizing the female by sight and by scent, climbs upon her back with no sort of preliminary. If she tries to escape he roughly seizes one of her legs in his jaws, to avoid so lamentable a loss. The only sort of courtship is a degree of tactual stimulation to which he subjects her, tickling her with his feet as he crawls over her back. In at least two species the male, trailing a silk thread as he goes, ends by actually tying the female to the ground.

Web-Spiders.

But what of the spiders that spin webs ? The spider's web is all but unique in the whole of the animal kingdom, and to the spiders that use it, it has become practically an extension of the organs of touch. A great development of the tactile sense, which almost supersedes both sight and hearing, is thus found in web spinners, and in all their lives the vibrations of their web play a dominant part.

If we put a male house spider, Tegenaria, of the family Agelenidae, on the web of a female, he performs an action which is to be seen in no other circumstances. With his two palpi he vigorously drums upon the sheet of the web. The female, waiting in the tubular part, feels the web shaking. She wakes up, but she quite evidently realizes that these vibrations are produced by no fly or blundering food-morsel. She who will dart instantly upon the disturbance produced by any insect, and who cannot distinguish between a fly and a tuning fork, waits expectantly and lets the vibrations play all round her. And the male gradually approaches until he can touch her with his fore-legs.

Of the other families of web-inhabiting spiders it is not yet possible to speak with such certainty. More research, more observation of these too often

neglected creatures is wanted, and badly. It is a common enough sight in the autumn to see a male spider lurking on the outskirts of one of the beautiful round webs of the Epeiridae, and many will say that he fears for his life. It may be so, though I doubt it. He is on the threads of the web, and what airs he may be playing upon them we poor humans have no means of knowing. But his tune may, and probably it often does, surpass the beauty of human choirs to ears that are able to appreciate it.

Mr. Bristowe has recorded observations of one species, Meta segmentata, probably the commonest of all orb-web makers. If the female advances towards the lingering male, he tweaks the web in a way which apparently informs her that he is not a fly. When, later, she is engaged in eating, he walks over her, tickling her as he goes and drawing silk over her. Finally he stops beside her and wraps her up in silk as these spiders do their prey. But it does not seem that courtship is invariably his purpose in all this, for I have seen it end by his eating his enshrouded lady.

It is often said that the female spider is a cannibalistic tyrant who feasts upon her husband. Although this does sometimes occur among certain species, nothing could, as a generalization, be further from the truth. Not only is it possible that the reverse may occur, but a little observation of spiders at breeding time will show many webs inhabited by a peaceable pair. Some species will even live together in captivity without disaster, while in at least one case, the common spider known as Pholcus, husband, wife and family may all be found in the same web. It is altogether wrong to suppose that the actions we have been describing never have a happy ending and are but a prelude to murder.

The Physical and Optical Societies' Exhibition.

By T. Barton Kelly.

(*Formerly Editor of "Modern Science."*)

Held in London during January, the seventeenth annual exhibition of the Physical Society and the Optical Society illustrated the progress and discoveries now being made in these important fields of research, as is indicated by the following description of some of the more interesting exhibits.

THE extent of the advance made by British manufacturers of optical glass and optical instruments since pre-war days was conclusively demonstrated at the Optical Convention held in London in April last year. The exhibits themselves and the addresses given during the convention showed that in almost every department of the industry the British product had equalled or actually surpassed the traditionally high standard set by continental competitors. That claim has now been admitted abroad, and British lenses, particularly those employed in photography and cinematography, have gained a position of supremacy all over the world, especially in America and Japan. Even the great studios of Hollywood and other centres of the film industry in America are ordering British lenses for their cameras and projection apparatus.

The stimulus which success has given to our manufacturers was apparent in the annual exhibition held jointly by the Physical Society and the Optical Society last month. This exhibition showed also that in the application of science to industry and common life our research workers are not being left behind. For the most part, the ingenuity which is brought to bear on the problems of applied science is so technical in its application, that but little is heard of it except by those directly concerned. It is only when an exhibition such as this provides a means that the part played by the research worker in wireless, aviation, and shipping, the electrical and textile industries, and the testing of materials, can be seen and appreciated by the public.

A relatively important place in the exhibition was taken up by models designed to explain, either by three-dimensional representation or by analogy, some of the phenomena of wireless transmission and reception. Many of these would be of unquestionable value to teachers and lecturers, and it is hoped that their use will spread. One of the most striking was a model illustrating wave motion, a subject which we imagine the average student finds some difficulty in grasping from the usual textbook diagrams. This apparatus is essentially simple in construction, and consists merely of a series of laths pivotted at their centres on a stretched steel wire, and linked by a pair of spiral springs arranged symmetrically parallel to the wire. The transmission along the series of laths of any motion copies in this way, on a magnified scale both of displacement and time, the transmission of motion along a stretched wire. The model can be

FIG. 1.
APPARATUS FOR MEASURING SURFACE TENSION.
A few drops of the liquid to be tested are placed in the watchglass on the left, and the strength of its surface film obtained by twisting the wire until contact between the suspended ring and the liquid surface is broken, the point at which this occurs being measured on the recording dial seen on the right.

used to show progressive waves. reflection of waves at a fixed or free end, production of standing waves by two equal trains of waves moving in opposite directions, the effect on the phase at reflection, and of the boundary conditions and so on.

Recent progress in various lines of technological research was represented by a large number of exhibits, among which electrical measuring apparatus predominated. Another class relating to defence and navigation included an instrument designed to enable sea or aircraft to ascertain the relative strengths of diaphone fog signals. Here an adjustable resonator is employed, capable of being tuned to notes in the neighbourhood of 180 vibrations a second, and fitted at the end with a mica diaphragm. Movements of the diaphragm in response to sounds received by the resonator are communicated to a narrow metal band carrying a small mirror, by means of a pointed bearing attached to the diaphragm. The observer arranges the apparatus so that the image of the filament of a lamp can be viewed in the mirror by means of an eyepiece, and when the diaphragm vibrates, causing the image to spread out into a band, he can measure the width it attains by means of a scale with which the eyepiece is provided.

An analogy model which aroused much interest demonstrated the production of beat-notes, thus making clear one of the mysteries involved in the principle of "super-heterodyne" wireless receivers, in which incoming waves are combined with others of slightly different frequency, producing an effect beneficial to clear reception. It consists of six organ pipes normally of the same pitch. Two of the pipes are exactly tuned together, two are slightly "sharp" by varying amounts, whilst the remaining are "flat" by varying amounts. If the two true pipes are sounded singly or together only one tone is heard, but if one of the true pipes be sounded together with one of the pipes that is slightly flat, a third note is heard sounding like an increase and decrease of the volume of sound. This is the beat-note which is slow, because the difference in pitch is very slight; but if the pipe that is still more flat be sounded, a beat-note is produced that is more rapid than the first one. Similarly, if the true pipe be sounded together with the one that is slightly sharp, a slow beat-note is again heard, whilst if the pipe which is more sharp is sounded together with the true pipe a more rapid beat-note is again heard. In this way, then, if the ear of the listener could be trained to ignore the two fundamental notes, and to take notice only of the two beat-notes, the performance of the super-heterodyne receiver could be faithfully reproduced. The beat-note could be so increased in rate as to become a new musical note

A process which is attracting much interest on account of its possibilities in reducing the corrosion of aluminium, duralumin, and other aluminium alloys—the materials which enter so largely into the construction of aircraft, particularly of seaplanes—consists in producing what may be appropriately called a super-coating of aluminium rust on the surface of the metal. It is well-known that aluminium on

FIG. 2.
HOW MENTAL FATIGUE IS RECORDED.
In this improved model of the River-McDougall machine a continuous band of paper is drawn over a wheel by means of clockwork, past the slot which is seen in the lid. The patient has to note certain marks on the band, and from the results the state of his mental fatigue is measured.

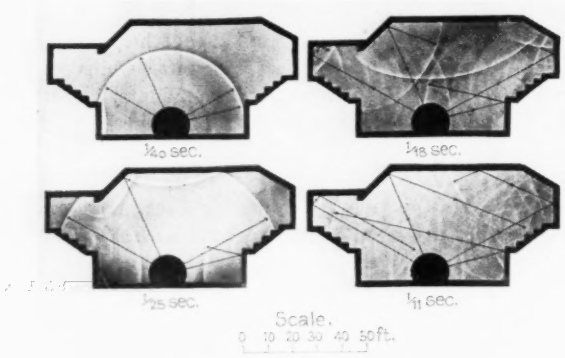


FIG. 3.
PHOTOGRAPHS OF SOUND IN MODEL AUDITORIUM.
Interesting discoveries regarding acoustics in building are being made with sectional models of buildings as seen above, in which the passage of sound waves after varying periods of time are recorded as shown.

exposure to the atmosphere becomes immediately covered with a transparent film of aluminium hydroxide, which serves as a protection against further attack. Dr. Bengough, whose name has been for many years associated with research on corrosion problems, found that by making the aluminium the anode or positive terminal in passing an electric current through a three per cent solution of chromic acid, a film of oxide is built up on the surface of the metal in the form of a dense uniform and smooth deposit, which greatly retards corrosion of the aluminium when exposed to the effects of atmospheric weathering or the action of sea-water. A minor—though not a trivial—property of this film produced by this "anodic oxidation" is its capacity for taking up colouring matter, such as azo dyestuffs, thus opening up an interesting field of possibilities in the colouring of aluminium when used for internal constructional purposes.

A particularly striking example of the ingenuity with which the research worker meets the individual problems that arise in the course of his work, was seen in the dew deposition recorder, an electrical device for showing how many times during a given period dew had been deposited on fruit under observation. Such information may be required, for instance, in the course of experiments on the storage of apples. The place of the apple is taken by a former on which two coils are wound. As the dummy apple is adjusted to have a heat capacity equivalent to that of a real one, it is clear that if the atmospheric conditions are such that dew deposits on the apples it will also deposit on the dummy. The two coils have adjacent turns, arranged so that a deposit of dew bridges the two circuits, and permits a current to flow when a suitable potential difference is applied to one end of each coil. A recording instrument in the circuit indicates the flow of a current between the coils.

As manufacturers recognize the advantages of employing scientific methods of testing both raw and finished product throughout the course of production, and this is becoming more and more the case in a host of trades formerly conducted on much more homely lines, a demand is created for new instruments and processes which can be used by skilled as distinct from expert workers. A large proportion of the exhibits belonged to this class. There were polarimeters, viscometers, and microscopes of special design and some less familiar types of apparatus also constructed with this purpose in view. For example, there was a simple and convenient device for measuring surface tension, that is, the strength of the surface film of any liquid. This instrument (Fig. 1), designed originally by Dr. P. L. du Nouy, can be employed for liquids of all kinds, and in fact provides the only method by which the surface tension of colloidal liquids can be determined. A distinct advantage lies in the very small quantity of liquid required for the test, and in dealing with such things as biological fluids this may be a consideration of supreme importance. A small watchglass containing the liquid is placed on a platform, which brings it under a small loop of platinum wire suspended from a light steel lever. The other end of the lever is attached to a fine steel wire stretched between supports on the stand. All the operator is required to do is to adjust the platinum loop so that it is in surface contact with the liquid, and then by means of a thumbscrew twist the stretched wire until eventually contact with the liquid surface is broken. The degree of torsion necessary to effect this is registered on a scale giving a result which is readily converted by calculation into dynes per centimetre—the units usually employed in this connexion.

Chemical Analysis.

The stand of a well-known firm of optical instrument makers afforded evidence of an interesting development in the use of the spectroscope for purposes of quantitative chemical analysis. This firm has put on the market a convenient form of quartz spectrograph, by means of which a trained observer is able to identify and estimate impurities in metals and alloys, thus obviating the necessity for the usual wet methods, and offering a handy and rapid means of assay which is sufficiently sensitive and reliable within the limits for which it is recommended. The spectrograph referred to is adapted to produce an arc spectrum of the metal under examination, and is

provided with an internal wave-length scale that photographs directly on to the plate on which the spectrum of the test sample is to be recorded. The spectra of a series of standard samples containing various accurately known proportions of the impurity in question are already available. These spectra show characteristics in regard to the appearance and intensity of some of the sensitive spectral lines, mainly those known as the lines of de Gramont, and thus by comparing the spectral lines of the metal whose impurity content is unknown with those of the standards, it is possible to make estimations which in general enable one to distinguish between .001 per cent, .01 per cent, .1 per cent, and 1 per cent, of any metal present as an impurity in another. As the percentage of impurity increases, other lines than the sensitive lines of de Gramont appear, showing a progressive increase in intensity varying with the amount of impurity. These lines are readily distinguished by photographing a comparison spectrum of the impurity itself, and it is possible to compile data for each metal enabling a rapid assay to be made in this way.

Another instrument in the trade section recalled the investigations which are being prosecuted in works and factories into the onset of fatigue and methods of preventing or delaying it. This was a new and improved model of the River-McDougall machine (Fig. 2), which furnishes a chart indicating the degree of distraction of the attention caused by mental fatigue or by external occurrences. A continuous band of paper about twenty-five millimetres wide is drawn by means of clockwork at any desired rate past a slot in the lid of the case in which the mechanism is enclosed. The paper is marked with small red circles spaced five millimetres apart along the length of the band, but at irregular positions across the width. The subject is required to mark with a needle the centre of each circle as it passes the slot, the speed of the paper band being so adjusted that the subject is forced to exert his maximum effort of attention to keep pace with it. His mental condition at the time is indicated by the number of circles he has missed or marked imperfectly. Another, and an obvious application of the test, is the determination of individual capacity to concentrate on a task, and in this respect different subjects show, it is said, widely different standards of performance.

Progress in the study of acoustic phenomena encountered in buildings was represented by a further series of sound pulse photographs, obtained by Dr. A. H. Davis and Mr. N. Fleming at the National Physical Laboratory. In these experiments model sections of buildings are employed, and by means of a technique, details of which have not yet been made public, the reflections caused by corners and boundaries in the sound waves created by an electric spark are registered as a shadowgraph on a photographic plate. The spark which produces the pulse of sound is followed after a short interval by a "light spark" which casts a shadow of the sound wave upon the screen or plate, since the greater refractive index of the air in the compression produces a deviation in the rays of light passing through it. A few of these photographs taken in a small model auditorium are here reproduced (Fig. 3), and in them the reflection caused by the roof, the walls, and each of the galleries at various stages in the history of the wave can easily be traced.

Correspondence.

THE CANADIAN MUSK PLANT.

To the Editor of DISCOVERY.

SIR,

Up to about twenty years ago the Musk (*Mimulus moschata*) was a sweetly-scented little plant much grown in cottage gardens and as a window plant. For some reason which it is difficult to explain it has now lost its scent. The reason for the disappearance of fragrance in the Musk plant has completely baffled all scientists who have investigated the subject; many theories have been advanced in explanation, but none of them are satisfactory. In a letter in your January issue, the suggestion is made by Dr. Hampton that a scented strain might be reintroduced from British Columbia, the native habitat of the Musk plant. The same idea occurred to the late William Watson, for many years Curator of the Royal Botanic Gardens, Kew, but careful search by botanists in British Columbia failed to detect the least evidence of scent in the Musk plant even in its native habitat.

There are gardens in England where Musk has been grown on the same spot and from the same stock for thirty years, and probably much longer. Many garden owners have so long associated this plant with its scent, that they are still under the impression that they have the true scented plant. I have had so-called scented Musk sent to me from different parts of the country, under the impression that the plants still retained their fragrance, but in no single instance was there the least trace of scent. It is no exaggeration to say that I have examined thousands of plants within recent years. The last time I remember the delicious odour of the Musk plant was in the Royal Gardens, Frogmore, about 1907. I am under the impression that the flowers were scented, not the leaves, as it was when the plants were in full bloom that the scent was most noticeable. It is one of the most pleasing of all plant scents. The reintroduction of a scented strain of Musk would be a source of joy to many thousands and a fortune awaits the man who can do it.

Yours, etc.,

HERBERT COWLEY,
Editor of *Gardening Illustrate*

17th January, 1927.

Dorton : A Forgotten Spa and its Water.

By C. Ainsworth Mitchell, M.A., F.I.C.

Interesting new light on a spa that was created in Buckinghamshire early last century is now forthcoming from analyses of the water undertaken by the author, who is editor to the Society of Public Analysts. It has been discovered how far the extravagant claims of the exploiters of the spa were justified and what changes in the properties of the water have since occurred.

DURING the later half of the eighteenth century the older English spas were at the height of their fame, for they had then become firmly established as fashionable resorts and had their yearly seasons thronged by London society. In those days it needed only the advertisement of a visit from royalty to make the fortune of the lucky owner of every mineral spring in the district. Towns such as Buxton, Tunbridge Wells, and Cheltenham had thus become famous, whilst other places with mineral springs of equal value were never visited, since no leader of society had set the fashion.

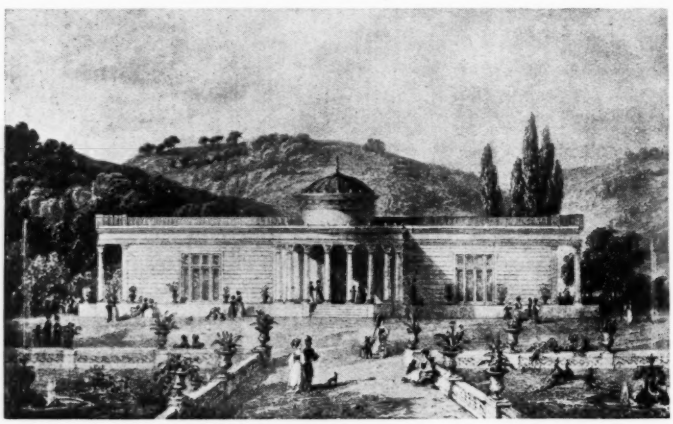


FIG. 1.
EAST FRONT OF DORTON SPA, 1833.
View of the building, from the first edition of Dr. Knight's local guide published in that year.

The end of the long Napoleonic Wars marked the close of this period of prosperity for the English spas. The continent of Europe then became more accessible, and its numerous spas began to attract many of the important visitors who had previously gone to Buxton or Tunbridge Wells.

This change in the tide of fashion was, to a large extent, brought about by English medical men who established consulting practices in the places which they recommended to their patients, and the books written by them to give information about the continental springs, and incidentally to advertise themselves, are amusing to read, for their comments upon one another recall the leading articles of rival newspapers of that time.

Simultaneously with this neglect of the old English spas there started a movement for the development of new ones, and a period of speculation set in. Wherever a spring was found with any pretentions to a saline character, it was exploited as a "spa." Companies were floated in every direction, each with an attractive prospectus, pump-rooms and baths were built in the approved classical style, and it was the fond hope of the promoters of these commercial ventures that they would attract some of the visitors from the continental spas. But few of the new spas attained lasting success; most of them have long been forgotten, although their names are still retained by "spa" hotels in different parts of the country, and the dilapidated pump-rooms of some of them are still standing in remote country villages.

Among the most interesting of these attempts to create a new English spa was the Dorton project, for the spring has a curious local history, and its water is of a very unusual composition. The village of Dorton lies at the foot of Brill Hill, an isolated offshoot of the Chiltern Hills about ten miles from Aylesbury. As will be seen on referring to an old map of Buckinghamshire, the position of the well was a strong factor against the success of the spa, for it was over fifty miles from London and the roads were hilly and bad.

Only a weather optimist and an inveterate early riser could have written: "The parishes of Brill and Dorton may truly be designated the Montpellier of England, presenting in the low lands an Italian climate, and on the hills as pure and invigorating an atmosphere as can possibly be conceived, *and that within a morning's drive of the metropolis.*" The italics are in the original, and to forestall possible

objections the doctor adds in a footnote : " The author has often left Brill in the morning and breakfasted at half past nine at his residence in St. James's Square."*

The mineral spring which was developed into Dorton Spa had long been known in the district, although one must hesitate to accept the statement of Lewis in his " Topographical Dictionary of England " (1849), that it was " well known to the ancient Britons, and obtained for the place the appellation of *Dwr*-ton, the town of the waters."†

Owing to the astringent taste of the water the well was commonly described as the " alum well." The ground for a radius of many feet from the spring was stained yellowish-brown from the constant deposition of iron oxide and basic iron sulphate, and no plants could grow in that soil.

In Lipscomb's " Antiquities of Buckinghamshire " (Vol. I, p. 246) there is a grandiloquent description of the beginning of the spa : " . . . little was heard of its medicinal effects, unless from its occasional use in cutaneous diseases, and the custom of washing mangey dogs in the water, until modern improvements in the roads, facilities of communication, and the march of intellect concurred to invite an influx of visitors, ' since when the number of people resorting to the spring became so great, and the injury done to the fences and herbage (always regarded with peculiar jealousy in a district abounding with game), that it was judged proper to restrain the peasantry, who flocked thither, to one path and to regulate the supply of water.' "

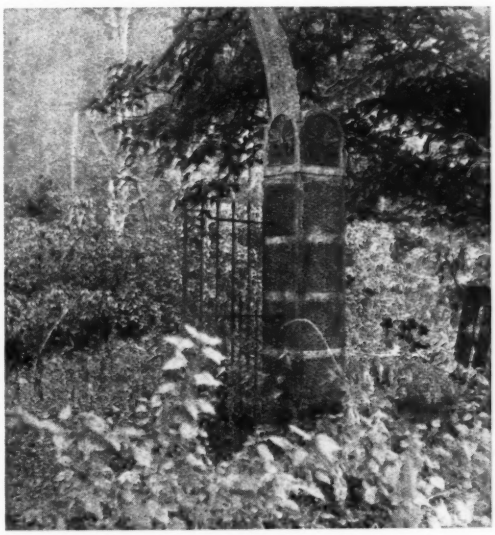


FIG. 2.
THE LAST OF THE DORTON SPA, 1912.
One of the gate-posts at the entrance facing the east front, the only trace of the spa that was still standing when the author first analysed the water in 1912. To-day nothing remains.

Lipscomb is here quoting from a guide to the spa which was published in 1833 by T. Knight, surgeon. In a footnote to this little handbook (p. 14) a different version, too good not to be quoted, is given of the use to which the water was put as a tonic for dogs : " When the diabolical practice of bull-baiting was the frequent accompaniment to our village feasts and wakes, the dogs intended for the match were brought hither from all parts for several successive Sundays previous, not only to be immersed in its stream for its tannin effects, but large quantities were also forced down them for its invigorating powers. This plan must have recommended itself from its frequent adoption, and was discontinued only by the threats of the tenant finding the practice amounting to a very considerable nuisance on his farm."

The pump-room and baths were built about the year 1829, and Dr. Knight informs us that the building was modelled upon the Tower of the Winds at Athens, with decorations from the Temple of Jupiter Stator in Rome, and that " confident hopes were entertained that Dorton would soon rival other watering places of fashionable resort, and that many a line of villas would speedily grace the spot." Happily for the beauty of the countryside, these hopes were not realized, although the commercial side of the enterprise was carried out with such thoroughness that it deserved success.

A view of the east front of the building is given in the first edition of Dr. Knight's local guide (see Fig. 1), and shows the main entrance, which was approached by a flight of steps leading up to a circular peristyle of ten columns.

From the commercial point of view it was the misfortune of Dorton Spa to have been developed half a century too late, for the water is undoubtedly a most remarkable one. It was analysed by Brande* about the time when it was proposed to open the spa, and the following results were obtained : —

Specific gravity at 60° F.	...	1.004
		Grains per pint
Sulphate of lime	... ...	11.5
Muriate of soda	... ...	1.4
Sulphate of alumina	...	2.1
Sulphate of iron	... ...	10.0
Total saline matter	... ...	25.0

* " The Dorton Spas, Bucks." By H. Willcocks Sleigh, M.D., London, 1842, p. 5.

† It is hardly necessary to say that this fanciful derivation cannot be accepted as a proof of the antiquity of the spring. According to the Editor of the English Place Name Society (Vol. I, Pt. 2, p. 22) the name " Dorton " was derived from the Old English *dor*, meaning " door " or " gate," and then topographically " a narrow pass."

* W. T. Brande, F.R.S., 1788-1866. Succeeded Davy as Professor of Chemistry at the Royal Institution, 1813. Master of the Mint, 1825.

There were also traces of carbon dioxide, nitrogen, and silica, and 0.8 per cent of free sulphuric acid.

In 1912 I took a sample from the well and analysed it. When freshly drawn the water had a yellow fluorescent appearance, due to suspended particles of basic iron sulphate. These rapidly subsided, leaving a clear liquid, which on contact with the air became turbid from the separation of more iron. After standing for two months in a partly filled bottle, the amount of deposit was 3.3 per cent of the total salts present. The specific gravity of the water at 15.5°C. was 1.0041, and on evaporation it left a residue of 433.2 parts per 100,000, consisting largely of a hydrated iron sulphate from which the combined water could be expelled at a higher temperature than 100°C.

In November of last year I analysed another sample of the water. The specific gravity had now fallen to 1.00355, corresponding to a decrease in the dehydrated total solids of 33 parts per 100,000.

The following table shows the variations in the composition of the water during the last ninety-six years, and for the purpose of comparison I have calculated Brande's results into the modern mode of expression in ions per 100,000.

	Brande. 1829.	Mitchell 1912.	Mitchell 1926.
Sp. gr. at 15.5°C. ...	1.004	1.0041	1.0036
Acidity, per cent. ...	0.8	0.1	0.04
	PARTS PER 100,000.		
Iron	32.0	45.6	21.70
Aluminium	3.52		9.52
Calcium	31.30	40.0	35.56
Magnesium	—	15.0	9.84
Sodium	6.29	8.5	19.94
Sulphuric acid (SO_4)	202.89	243.0	201.55
Chlorine	9.71	10.0	24.85
Silica	trace	trace	6.20
	285.71	362.1	329.16

The main differences between the 1829 and 1912 analyses is the increase in the iron and combined sulphuric acid, and the appearance of a large amount of magnesium, which Brande could hardly have missed. In the last fourteen years there has been a pronounced fall in the amount of iron and magnesium, and a great increase in the amounts of sodium and chlorine and combined silica. Apparently iron has been precipitated as basic ferric sulphate, and the magnesium has been reduced by precipitation or dilution, while the water has been enriched by sodium chloride. The whole of the iron is now present in the ferric condition, and a natural water containing so large a proportion of iron is remarkable, none of the old chalybeate springs having anything approaching this quantity. Buxton water, for instance, contains only about 5 parts, and Tunbridge Wells water about 8 parts per 100,000. There was thus some justification for Dr. Knight's flowery prophecy in 1833 (*loc. cit.*, p. 95) :—" The water of Tonbridge Wells being a chalybeate, and having now become established in its fame, with a beautiful town grown up around it, where annually rank and beauty crowd to recall the lost hue of rosy health to their cheeks—I simply ask what ought to be the fate of Dorton whose waters flow so much more strongly impregnated with the health-giver Iron ; if one in two centuries has risen to fame, to what ought not the other to aspire in a few years ? "

In addition to the dispensing of the water at Dorton an establishment was also opened for its sale in London, and detailed accounts were published of the marvellous cures said to have been effected by its use.

But in spite of judicious advertising and the establishment of a Spa Rural Hotel, the wealthy visitors who were needed to make the spa a success seldom came, and even the attempt made in 1842 to supply " convenient residences for the nobility and gentry " failed to attract them, and *promenades musicales* and fetes gave only a temporary stimulus to a venture that was on the decline.

Before the close of the 'forties the pump-room was shut up and abandoned, and gradually fell into ruins, and early in the present century the building, which had become unsafe, was pulled down. In 1912 the only trace of the spa still standing was one of the gate-posts at the entrance facing the east front (Fig. 2), though the extent of its buildings was indicated by the masses of shapeless heaps of stone and rubble overgrown with weeds lying in a dense wood. To-day, nothing is left.

So rapidly has Dorton Spa become a thing of the past that it is now almost as completely forgotten as are the mangey dogs which once were " tanned " in its spring, or those intelligent cattle which when " they laboured under any disease recurred to its use spontaneously and rapidly recovered."

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Cathode-Rays : A New American Tube

Invented by Dr. W. D. Coolidge.

Interesting experiments that have been performed with an improved "cathode-ray" tube, which may lead to discoveries even more startling than those made with X-rays, are described in the December issue of "The Scientific American," from which the following article is reprinted in slightly revised form.

It is no longer a secret that when the remarkable phenomena produced by means of the new cathode-ray tube invented by Dr. W. D. Coolidge, assistant director of the General Electric Company's research laboratories, were first observed—especially its effects on small animals at short distances—there was considerable fear among scientists that it would receive a bad dose of the wrong kind of initial publicity: it might be described by the sensational press as some new-fangled kind of "death-ray." No such purpose, it is almost needless to state, was in the minds of those who developed it, and its effect on living matter is so comparatively limited in range that any such idea would be nonsensical. As anyone may learn from any elementary physics textbook, the cathode-ray is not in itself a new thing—far from it. What Dr. Coolidge has done, essentially, is to modify the electron-discharge tube formerly used, in such a manner that the rays are powerful *outside* the tube in which they are generated. As the present article will explain, various interesting phenomena take place under the new "super-cathode" rays; although direct applications of practical value have not been announced as yet, experiments formerly impracticable should be possible with the new tube. It is significant, moreover, that most scientific developments have in the past soon been applied in some direct manner to industry and daily life.

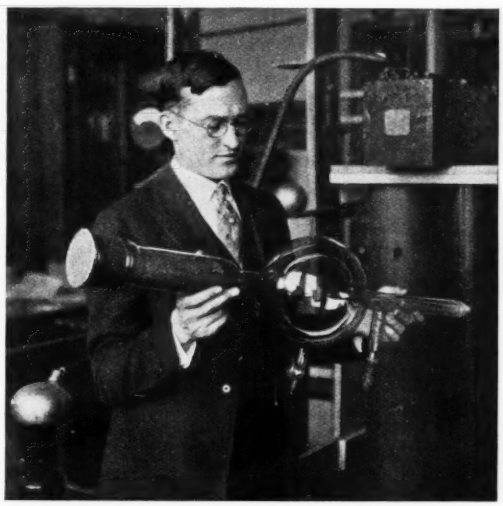


Fig. 1.
THE NEW CATHODE-RAY TUBE.
The rays emerge through the nickel "window," which is only one two-thousandth of an inch thick, seen at the left end of the tube.

Cathode-rays, *i.e.*, streams of high-speed electrons or minute charged particles of matter, originated from the work of Crookes in 1875, but their possibilities were limited because it was necessary to work within continuously evacuated tubes. Hertz, in 1892, found that the cathode-rays would go through metal foil placed in the vacuum tube. Lenard, his pupil, made a big step forward when, thirty years ago, he cemented a metal-foil window in the bulb of the tube and shot cathode-rays through it, and thereby for the first time obtained cathode-rays out in the air. Numerous advancements in cathode-ray tube construction have been made by other investigators since then, and the tube (Fig. 1) that has now been devised by Dr. Coolidge is characterized by greatly increased output, much higher operating voltages, and by being entirely sealed off from the exhaust system. Earlier tubes had to be kept continually attached during operation to an evacuating pump.

Practical applications for the new tube have not yet been developed, but, as will be described in detail later, its very high output has already led to the discovery of phenomena which had not been observed with previous tubes. Such, for instance, are the production of a yellowish solid when cathode-rays are passed through acetylene, a colourless gas; and the production of electrical discharges or explosions just beneath the surface layers of many substances. Work with a grey rabbit led to the production of growths of longer and white hair on rayed areas. When the leaf of the rubber plant was similarly bombarded, latex or milk was exuded. In addition to such results as these, cathode-rays, in smaller concentrations, were previously found by other observers to kill germs and spores, cause many salts to become brilliantly fluorescent or to change in colour, and to effect physical and chemical changes of different kinds.

Most of the effects are superficial phenomena, however, since the rays have relatively low penetrating power. At 350,000 volts they penetrate more than two feet of air (Fig. 2), but in substances of greater density, such as salts, the penetration is correspondingly less. The power of the new cathode-ray tube is evident in the statement that it produces as many cathode (or beta) rays as does a million grams of radium bromide, but of lower average velocity.

The window of Lenard's original cathode-ray tube was 1.7 millimetres in diameter, of aluminium foil 0.00265 millimetres thick, cemented to a metal plate in the end of the tube. The small diameter was the result of several circumstances. It was difficult to obtain a larger piece of such thin foil without minute holes, and it was difficult to support this thin piece of metal so that it would not collapse when the tube was evacuated. His tube was operated with a permanent connexion to a vacuum system, and depended for its operation on the presence of a small amount of gas in the tube. The gas molecules became split up into electrons when a high potential was impressed across the electrodes, through which the current was passed. The positively charged particles were attracted to the cathode or negatively charged terminal, and its bombardment by these positive particles liberated the electrons which constituted the main cathode-ray stream.

Construction of the New Tube.

In the new tube (Fig. 1) a current of a few milliamperes, at voltages up to 350,000, may be used. The window has a diameter of eight centimetres, and is of nickel, 0.0254 millimetre in thickness. The operation of the tube is similar to that of the modern pure electron-discharge X-ray tube, also a development of Dr. Coolidge's, in that the stream of electrons is liberated by a heated tungsten filament and in that a very high vacuum is used. The tube may be sealed off from the exhaust system, and transported and used as easily as an X-ray tube. Connected to the window, or anode—the positive terminal—there is a copper tube which serves as a shield to prevent puncturing of the glass by the high-power voltage.

The cathode is a heated tungsten wire from which the electrons come; the anode is a nickel window which is half of a thousandth of an inch thick and which is supported against the atmospheric pressure by a honeycomb structure of molybdenum. Reckoned in inches, the window is thin, but in terms of atomic layers it is thick—500,000 atom layers deep. The window is soldered to an invar sleeve to which the glass of the anode arm is sealed.

The filament is heated with a low-voltage current. Electrons evaporate from the filament at a rate determined by the temperature, which in turn depends upon the filament current. A high voltage is impressed between the electrodes, the electrons from the filament thereby being driven at enormous speeds from the cathode to the anode, through which most of them go into the surrounding air.

Experiments with the Rays.

The electrons escaping through the metal window cause the air to assume a purplish glow, extending in front of and for some distance back of the window. This luminous, essentially spherical mass may be as much as two feet in diameter, depending on the voltage, and is due to the activation of the air by the high-speed particles. The odour of ozone and the oxides of nitrogen gas is also noticeable. Impact of the electrons on the window causes a slight production of X-rays there, and additional X-rays are produced when the cathode rays impinge on other substances outside the tube. In addition to such phenomena as can be actually observed when a substance is placed in the path of the cathode rays, other things are happening. Matter of any kind in the path of the rays becomes heated by the bombardment of the rays, and at the same time becomes a source of X-rays, just as though it were within an evacuated tube. The general design of the new tube is such that it seems possible to use still larger windows and more energy.

The following experiments were conducted with a cathode-ray tube operating at 200,000 volts.

Calcite crystals, upon being rayed, glow strongly with an orange light and remain luminous for several hours. In addition to this, they may show bright, bluish-white scintillations, or sparklings (Fig. 2), which have been observed while the crystal is undergoing bombardment and for as long as a minute after raying. By lightly scratching the rayed surface of the crystal with a sharp instrument, the scintillations may be induced for as long as an hour after raying. The area in the neighbourhood of a scintillation loses all of its luminosity as the scintillation occurs, and then appears dark against the bright orange background. Under the microscope the spot is marked by a little crater, with many tiny canals leading from it. Examination of one of these areas with a microscope shows the presence of a fine network of lines radiating from each explosion crater. Each appears to be a line of small globules, like a string of beads. The reason for this beaded appearance is not fully understood.

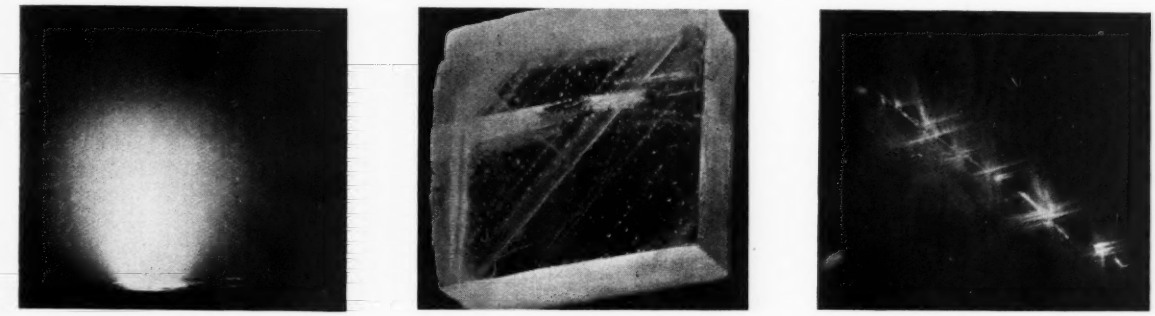


FIG. 2.

ILLUSTRATIONS SHOWING THE CATHODE RAY AND ITS EFFECT ON A SPECIMEN OF ROCK CRYSTAL.

Left.—The new ray escaping through the nickel "window" penetrates the air as a purplish glow two feet in diameter. *Centre.*—The crystals in a specimen of calcite exposed to the ray scintillate with a bluish-white colour in spots and emit an orange glow. *Right.*—Some of these scintillation spots are seen magnified.

The luminosity of the ordinarily colourless and transparent calcite crystal is weird and uncanny. To the uninitiated the mineral has the appearance of a red-hot coal, and is touched with reluctance. It is cold light, however, in that no appreciable temperature rise is apparent, and the crystal can be handled without danger. The luminosity occurs within a very thin layer since the rays penetrate only about one-tenth millimetre into the crystal structure.

Calcite is not the only mineral which is caused to glow by treatment with cathode rays. Some glow only while subjected to bombardment, and others continue to glow for some time; and various colours are apparent, according to the minerals used. In the case of granite, a mixture of different minerals, a very beautiful effect is produced by the rays, since such colours as orange, blue, red and green become evident. These colours are very brilliant while the granite is under bombardment, and persist less brightly for some time thereafter.

Fluorescent screens such as are used with X-rays are also caused to glow intensely when subjected to cathode rays. A beautiful experiment can be conducted with a fluorescent screen of cadmium tungstate. When subjected to cathode rays it gives off green light and shows very little phosphorescence, or afterglow. If a strip of this screen is dipped into liquid air and is then rayed, it shows, upon warming up, several distinct luminescent periods, each having its own characteristic colour, the colour depending upon the temperature. If, after the screen has somewhat warmed up and has passed through some of the colours, it is chilled again with liquid air and allowed to warm up once more, it will display no colour until it has reached the previous higher temperature. The screen then glows with the proper colour for that temperature. This radiant energy can be stored in the intensifying screen by maintaining a sufficiently low temperature, and can be liberated at any time by the application of heat.

One of the most interesting experiments with the cathode ray has been the production of a solid by passing acetylene gas in front of the window of the tube while it is in operation. The product, similar to or perhaps the same as that obtained previously in minute traces either by a corona discharge in acetylene or by the use of radium emanation, has been produced in gram lots with the new tube. In producing the compound, the gas is led through a chamber in front of the window of the tube, and the compound is formed immediately. It can be collected as a fluffy, yellow powder, or under different electrical conditions directly as a varnish-like film on metallic or other surfaces, to which it adheres tightly. The powder has been found to be insoluble in all the numerous chemical agents that have been tried so far in the experiments.

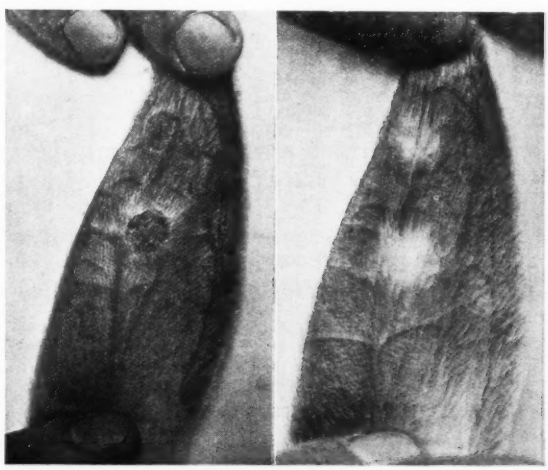


FIG. 3.

RABBIT'S EAR AFTER EXPOSURE TO THE RAY.

One second's exposure to the rays produced the scabs seen on the rabbit's ear (left) which soon peeled, taking the old hair with them. After two weeks, new white hair (right) has grown in its place

The high-speed electrons emitted by the tube cause many liquids and solids to undergo marked chemical changes. Just as acetylene is changed to a solid, so is castor oil solidified. Crystals of cane sugar become opaque white and, if heated afterwards, give off considerable quantities of gas. If a solution of sugar in water is exposed to the rays and then tested with litmus indicating paper, it is found that the solution has become acid. When a shallow dish of ordinary salt is exposed for a moment to the rays, the salt turns brown. By removing the surface layer of salt it is seen that the crystals beneath, not reached by the rays, have not been affected.

If glass is exposed to the rays, it immediately turns purplish or brownish in colour, similar to the way glass is affected by long exposure to X-rays. By the use of a metal stencil, the glass can be marked with any design, either very lightly or more deeply, depending upon the amount of exposure. Porcelain and crockery can be marked in a similar way. The colour effects produced by these experiments have been found to be more or less permanent, some colours being lost in a short time, and others continue indefinitely.

Electrical discharges or explosions occur in a sheet of celluloid exposed to the rays at about liquid-air temperatures. These sparks or scintillations are observed in a dark room during and immediately following exposure. Subsequent observation of the celluloid under a microscope will show that just beneath the surface there has been a discharge where each of the sparks occurred. The craters in the celluloid are shown by a microscope not as straight lines of globules, as in the case of calcite, but as very irregular lines, due probably to the fact that calcite is crystalline in structure and celluloid is not.

Biological Effects.

If the leaf of a rubber plant (*Ficus elastica*) is pricked with a pin point, a white latex or milk is exuded from the puncture. When a portion of the leaf is rayed with one milliampere of current for twenty seconds at a distance of one inch from the window, the rayed area becomes covered immediately with the white latex, indicating that the electrons have in some way caused the cell walls to become permeable to the latex. An exposure of only 0.1 milliampere for one second causes a colour change in the leaf, with subsequent drying out of the rayed area to a depth corresponding to the penetration of the rays.

X-rays do not kill bacteria, but the 200,000-volt cathode-rays do, even with an exposure of as little as one-tenth of a second. Further, one milliampere of current for a fraction of a second has been found sufficient to cause immediate paralysis and subsequent death of fruit-flies.

A peculiar effect discovered during experiments with rabbits is that a profuse growth of snow-white hair is produced by exposure to the rays (Fig. 3). The ear was rayed with 0.1 milliampere for 0.1 second over an area one centimetre in diameter. The rayed skin became deeply pigmented within a few days, and the hair came out. Seven weeks later, new hair appeared. This new hair was longer and was a mixture of white and grey in colour. With one hundred times the exposure—one milliampere for one second on a similar area—a scab formed over the rayed area. The scab came off a few days later, taking the hair with it. A profuse growth of snow-white hair started two weeks later, and soon became much longer than the original hair. In further experiments the exposure was increased to one milliampere for fifty seconds. Scabs developed on both sides of the ear, and when they fell away a hole was left in the ear. The edge of this hole was at first without hair, but later became covered with a growth of the snow-white hair.

Comparison with Radium.

Among the most important of ray-producing devices or substances available for scientific research are radium compounds and similar products. They are constantly disintegrating and, in so doing, give off alpha, beta and gamma rays. The beta rays are really high-speed electrons, and in this respect are identical with those of the cathode-ray tube, but of higher average velocity.

Radium, however, is uncontrollable in that the experimenter cannot govern the velocity at which the electrons are bombarded into space. The cathode-ray tube offers a source of high-speed electrons, or beta rays, which is at all times under the control of the experimenter, both as to quantity and velocity. Added to this there is the fact that one of the tubes will produce a very high concentration of the rays—one tube releasing as many electrons per second as a million grams of radium bromide.

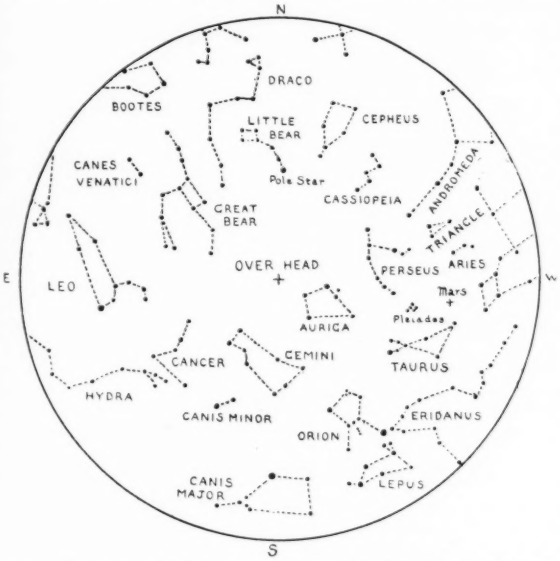
Much has been learned in the past of the properties of cathode-rays by brilliant experiments conducted by numerous investigators. With the new tube—completely sealed, portable, always under control, capable of producing a very powerful stream of high-speed electrons—the field has been opened for conducting experiments previously impossible, and it is to be expected that our understanding of electronic phenomena will be greatly increased thereby.

Among the Stars: A Monthly Commentary.

THE HEAVENS IN FEBRUARY.

By J. A. Lloyd, F.R.A.S.

THE chart herewith depicts the aspect of the principal star-groups as seen from London on 1st February at 10 p.m., and on 28th February at 8 p.m. Planets visible this month



are: Mercury, which is a naked-eye object in the west about the 20th of the month, when both Mercury and Venus may be seen near each other, Venus being the higher of the two and slightly to the left of Mercury. This will give those who have never seen Mercury a good chance to find this elusive planet. Mars is also a conspicuous object, and will be seen due south at about 6.30 p.m. at the beginning of the month. Jupiter has practically passed out of sight, though it can be seen close to Venus on the 5th of the month. Saturn is visible in the south-east in the early morning between 3 a.m. and 4 a.m. towards the end of the month.

Research on Sunspots.

There are signs that the present sunspot cycle is nearing its maximum, and some exceptionally large sunspots have lately been noted on the sun's disc. No fewer than four sunspots large enough to be seen with the naked eye were visible at one and the same time on a recent occasion. It is not, therefore, very surprising to find that astronomers have once more turned their attention to the theory of sunspots. The latest worker in this fascinating field of research is Professor V. Bjerknes, who has worked out an elaborate theory by which he seeks to account for all the phenomena connected with sunspots on the principles of hydrodynamics and thermodynamics. Of course, it is too soon yet to say that the new theory is perfect, for time and further observation may show weak spots in it. But so far it appears to square with the facts in a remarkable fashion. The Professor starts on the assumption that sunspots are vortices which, in fact, is shown by the spectroheliograph, the instrument used for photographing sun prominences, and was suspected long ago by Father Secchi and other early workers. Bjerknes also assumes that the magnetic fields associated with sunspots are so connected with the vortical movement that a change in the magnetic character of the field results from a change in the direction of whirl. He proves how, on mathematical principles, the centre of a sunspot should be cooler than the surrounding region, and estimates what the difference in temperature should be. It is to his credit that observation, here at least, supports the theory. He regards the vortex as commencing at some depth below the sun's surface, where the vortical motion is zero, and increases regularly up to the surface. He further supposes that all the sunspots of a given cycle have their origin in a single "vortex-ring" situated below the level of the photosphere, or visible surface of the sun. Such a vortex-ring would not be stable but would tend to rise up in places through the photosphere. Where the ring cut the surface we should have two spots, which is precisely the normal condition of things, the bipolar sunspot being well-known to all observers. Arguing along these lines, Bjerknes shows how the two members of the double spot must be of opposite magnetic polarity, which is also supported by observation. He suggests that in each hemisphere of the sun, northern and southern, there are two zonal vortex-rings surrounding the sun parallel to the equator and having opposite rotations. If such a vortex-ring tended to drift towards the solar equator, it would explain why the spots of each cycle appear to move nearer and nearer to the equator as the cycle advances. Bjerknes points out that the cooling of the photosphere by radiation would set up a circulation which might well be in a direction from the poles to his equator. He assumes this to be so, and shows that one consequence would be the observed lag of the surface rotation from the equator to the poles. He also suggests that the sun should be hottest at the poles and coolest at the equator, the difference in temperature being, however, very small. Professor Bjerknes, in brief, regards sunspots as vortices in which matter in the form of hot gases is forced up from below, cooling in the process. However, the gases forming the core of the vortex soon become re-heated and expand outward, their place being taken by fresh supplies from below, and will spread out radially from the centre of the spot. To make good the losses from below, there must be a corresponding descending flow from the strata above the photosphere. On account of the sun's rotation, the falling gases will assume a spiral formation, another matter which is borne out by the spectroheliograph. Such are the main features of the theory, but it is sure to come in for its share of criticism before it is finally accepted by the astronomical world.

The New Comet.

The comet discovered by Professor José Comas Sola, of Barcelona, on 5th November last has now been shown to belong to the Jupiter family in all probability. During the month of February it will be well placed for observation, and should be visible in quite a small telescope; but it is not likely to become a conspicuous object. At the beginning of the month it will be situated between the Pleiades and the chief stars of Aries, about four degrees to the right (west) of Mars.

The Month's Wireless Developments.

PROGRESS IN TELEVISION.

By F. H. Masters.

Editor of "The Electrician."

As the wireless event of the past few weeks, the inauguration of the public telephone service between London and New York, has naturally been full described in the daily and weekly press, it will not be inappropriate in view of the popular interest the subject is now attracting to devote my notes this month to television, and especially to the important work which has been done in this field by Mr. John L. Baird. In a recent issue of *Discovery* the wireless transmission of photographs was dealt with; and to avoid confusion it may be pointed out that television is the transmission of images of actual scenes or objects to a distance, rather than the transmission of photographs of those scenes or objects. Etymological purists do not like the term, but it is convenient, and the chief real objection is that it may be used to describe two different processes, processes too, which have given rise to entirely different problems.

The general principles by which television might be obtained have long been known. An image of the object or scene to be transmitted is made to traverse a light sensitive cell, thus causing the current generated by this cell to vary in proportion to the light and shade of the image. This varying current is transmitted to a receiving station, where it controls a point of light traversing a screen in exact synchronism with the traversal of the image over the light sensitive cell at the transmitter. If this process is repeated sufficiently rapidly the eye will see the whole image reproduced owing to the persistence of vision.

In the early experiments, now dating back some years, selenium was used as the light transmitting material, but it was soon found that it did not follow the changes of illumination rapidly enough. Success was finally achieved by the employment of a photo-electric cell, combined once again with the thermionic valve. Though this overcame the inertia difficulty, it produced another in that the photo-electric cell did not respond sufficiently to the very small quantity of light available. That this quantity of light is very meagre is obvious from the statement that what matters is the amount reflected from a small area of the object, which is being transmitted. For instance, the total light reflected from a brightly illuminated human face is less than one candle-power. Fortunately, amplification by the valve is possible to a certain extent, but here again difficulties were experienced owing to filament emission.

Transmitting Shadows.

Mr. Baird courageously, therefore, attempted to tackle the problem in a new way by focussing his attention on the transmission of the shadows of the object rather than of the object itself. In a shadowgraph the light is not reflected, so that the full illumination from the source of light falls directly upon the cell. The cell has then only to distinguish between the total darkness and a light which may be very intense. Having succeeded in transmitting shadows, the next step was to transmit images of objects by reflected light. This marks an immense difference from the earlier ideas, but after a considerable amount of work, and even of failure, it was at last achieved, principally as a result of close investigation and research on the photo-electric cell. The final result of this stage in the progress that has been made is that an image with details and half-tones can now be transmitted. Much, of course, yet remains to be accomplished, but the defects are mainly matters of mechanical, optical, and electrical detail; and they are being steadily eliminated. Recently, a most important advance has been made. At first, for reasons stated above, it was necessary to use very intense illumination. Now it has been found possible to dispense with light rays altogether, and to use those which are usually called "infra-red."

The image having once been imposed on the photo-electric cell its transmission can be effected either by telephonic or wireless methods in the shape of sound and electric waves. Such transmission cannot, of course, be received as vision by the ordinary receiver, but requires retransformation into light rays.

The system opens up a range of wide possibilities, especially in connexion with broadcasting and the talking film.

BROADCASTING NOTES AND NEWS.

By Edward Liveing, M.A.,

Manchester Station Director, B.B.C.

It is significant of the general trend towards some degree of State supervision of wireless programmes that even France, hitherto one of the most backward European nations in moving in this direction, has drafted a decree for State control of broadcasting, which was passed by the Cabinet early in January. The decree still awaits ratification by Parliament and, even if it is passed, it will not come into force for five years. When, and if, it does come into effect, however, a very remarkable change in French broadcasting will take place. All the stations will be nationalized, and all the programmes will be directed by a board consisting of representatives of the general public, the public services, the wireless industry, and authors, musicians, and other artists.

The visitor who has spent any length of time in Paris during the last year or so will know that advertising forms an important part of the revenue of French broadcasting stations, for doubtless he will have been beguiled, or otherwise, by the wireless programmes, interspersed with frequent advertising, thrown out at him through loud-speakers in the Paris streets. This doubtful pleasure will be denied him in future, for the police have issued an edict which will prohibit these loud-speakers from functioning on the ground of their interference with traffic regulations.

Many readers will be interested to know that a new book on broadcasting has just appeared under the title of "Radio Drama and how to write it" (George Allen & Unwin Ltd.). The book has been written by Mr. Gordon Lea, and it contains a foreword by Mr. R. E. Jeffrey, the Productions Director of the British Broadcasting Corporation. Broadcasting has led to the development of new art forms and perhaps the most distinctive art form, which it is gradually producing, is that of the wireless play, for which no footlights and no stage scenery are needed. It was inevitable that, in the outset of broadcasting, recourse had to be made to existing stage plays. Many of these plays have been adapted to the wireless medium; a few have been broadcast in their entirety. Side by side with these plays, plays specially written for the wireless medium

have been introduced from time to time. Though it is always rash to make prophecies in the early development of a new art, we can say that two special forms of wireless plays are now emerging. The technique and the possibilities of these special types of plays are very ably described in Chapters IV and V of this book. Mr. Gordon Lea entitles them respectively, "the narrator method" and the "self-contained method." Mr. Lea very decidedly favours the latter type of radio drama. This type of play has been very rarely used. As Mr. Lea points out, "the setting of the play must be indicated by the characters themselves." In fact, this method does away with all announcements, the dialogue itself drawing for the listener the necessary mental pictures of characters, plot, and change of scene. It is impossible in the limits of these notes to give any of the interesting examples of this type of drama which Mr. Lea offers in his book. This form of play is theoretically a great advance on other plays from an aesthetic point of view. It would be difficult to agree with the author that the other method—the narrator method,as he styles it—is not good as a form for riginal radio drama. It has its practical advantages over the self-contained method, for gulfs of time and space can be bridged over by the announcements of the narrator and it is thus more suitable for dramas of an episodic character. Another stimulating chapter in the book is the final chapter dealing with "Effect on Literature," while listeners themselves would be well advised to read the chapter which will give them sound advice on how to listen to radio plays. Altogether the book meets a long-needed want, and one will hope that it will stimulate writers to turn their attention to this new art form.

Voice and Personality.

In my notes next month I hope to be able to give some interesting details and statistics about the recent psychological experiments conducted from the Manchester Station, and S. B. to all stations, on the evenings of 17th, 20th, and 21st January. The experiments were conducted by Professor T. H. Pear, Professor of Psychology of Manchester University, and listeners were asked to send in their opinions as to the characteristics and occupations of the nine persons, each of whom broadcast the same short story. How far the human voice can convey a speaker's personality has never before been ascertained with any degree of certainty, and it is hoped that this experiment will be the means of developing a branch of psychological research which has hitherto not received much attention.

Book Reviews.

The Elizabethan Zoo : A Book of Beasts both Fabulous and Authentic. Edited by M. St. Clare Byrne. A Haslewood Book. (Etchells & Macdonald. Limited edition of 525 numbered copies. 32*s.* 6*d.*).

Edward Topsell of Christ's College, Cambridge, who provides most of the selections which make this book, was a man of wide interests and diverse gifts. He was also the holder of much church preferment and was, according to the habit of his times, a pluralist. Amongst others of his works he published "Lectures upon the Booke of Ruth" (1596), "Times Lamentation, an Exposition of the Prophet Joel" (1599). But his chief claim to fame is his zoological works, which are mainly compiled from the books of Conrad Gesner. Although Gesner was introducing some order into zoology he, like other writers of his time, dealt with many fabulous beasts, and although his industry was enormous he was not of a very critical mind. Topsell's two great folio volumes, the "Historie of Foure Footed Beastes, Describing the True and Lively Figure of Every Beaste," and his second publication, the "Historie of Serpents," are illustrated by the quaint figures he has accurately copied from Gesner. The books are in large quarto and very closely printed, so that the reading of them requires both time and good eyesight. Some of the chapters are very long; that on the horse extends over one hundred and fifty-five pages. There is a very full list of authors who have written on beasts, including Hebrew, Greek, and modern writers, amouuting to several hundred entries. As an example of the queer facts that are here recorded, we may quote the chapter on the Boa. According to the picture it is an animal covered with scales and from the size of its body it has evidently had an extensive meal, yet it is still clasping an infant in its mouth. Its tail ends in an arrow-shaped organ and the eyes are conspicuous.

THE BOAS.

The Latines call it *Boa* and *Boua* of *Bos*, because by sucking Cowes milke it so encreaseth, that in the end it destroyeth all manner of herdes, Cattell and Regions. And our domesticall Snakes and Adders, will also sucke milke from Kine, as in all the Nations of the world is most manifest to them that will observe the same.

The Italians doe usually call them, *Serpeda de Aqua*, a Serpent of the water, and therefore all the Learned expound the Greeke word *Hydra* for a Boas. *Cardan* saith, that there are of this kind in the kingdome of *Senega*, both without feet and wings, but most properly they are now found in Italy, according to these verses :—

The Boas Serpent which Italy doth breede,
Men say, uppon the milke of Cowes doth feede.

Their fashion is in seeking for their prey among the heardes, to destroy nothing that giveth suck so long as it will live, but they reserve it alive untill the milk be dryed up, then afterward they kill and eate it, and so they deale with whole flocks and heards. The poyson of it, saith *Festus*, maketh tumour and swelling in the body, whereunto all others agree, except *Albertus*, who in this point agrees not with himselfe, for in one place hee saith that they are venomous, and their teeth also like other Dragons, in another place he saith, their poyson is very weake, and not to be regarded, because they be Dragons of the third order or devision. They goe all upon their belly, and so I will conclude their story with *Mantuan*.

Turpi Boa flexilis alvo,

that is to say,

The filthy Boas on his belly mooves.

One may record that cats are considered very harmful and perilous to man, their "breath and savour consume the radicall humour and destroy the lungs, and they which keepe their cats with them in their beds have the aire corrupted and fall into fever hecticks and consumptions." They are also said to poison a man by looking upon him : "wherefore there is in some men a naturall dislike and abhorring of cats, their natures being so composed, that not onely when they see them, but being neere them and unseene, and hid of purpose, they fall into passions, fretting, sweating, pulling off their hats, and trembling fearefully." It is a well-known fact at the present day that many people, like the late Queen Victoria and Lord Roberts, had a special dislike for cats and are aware of their presence in a room even when they are completely out of sight.

The present book is well got up and is a useful record of zoology as understood in the time when Shakespeare lived.

A. E. S.

Our Mobile Earth. By REGINALD A. DALY, Sturgis-Hooper Professor of Geology in Harvard University. (Charles Scribner's Sons. 21s.).

In "Our Mobile Earth" Professor Daly has attempted the difficult task of discussing in simple language modern views concerning the structure of the earth, and the origin of its surface features.

These are subjects concerning which there are several schools of thought, and although the author's aim has been to give a "review of those discoveries and conclusions which appear to be consistent among themselves, and to indicate the broad outlines of our globe's development," he has done so with the provision that "It is inevitable that an author should stress those essential speculations which appeal to him as the soundest." This being the case, it is not to be expected that all the views expressed in the book will meet with universal acceptance, but the present is not the occasion on which to criticize the author's conclusions.

Commencing with an account of earthquakes and volcanic phenomena, and the light which they throw upon the nature of the earth's interior, Professor Daly uses the evidence obtained as the basis of a discussion of the supposed conditions of the earth in its infancy. This is followed by chapters dealing with the origin of mountain ranges and the evolution of the earth's present surface features.

Like Dr. H. Jeffreys, Daly favours the idea that the earth is a continually cooling body, and that mountain ranges are the outcome of the shrinkage due to that cooling. The continental masses are regarded as consisting essentially of granitic rocks and their sedimentary derivatives, floating upon a substratum of heavier basaltic material, the lower layers of which are potentially plastic. In this, his views have much in common with those of Wegener and Joly. It is difficult in a few words to do justice to the chapters containing Daly's views concerning the operations of the forces which have been responsible for the folding and upheaval of mountain ranges. The stages he postulates are as follows:—

A considerable thickness of sediment accumulates in a region of crustal depression (a geosyncline); the underlying granitic crust breaks under the strain; a portion of it sinks into the glassy basaltic layer beneath giving rise to a tract over which the lighter sedimentary rocks of the geosyncline float directly upon the glassy basaltic layer. Owing to the existence of the crustal depression in which the sediments accumulated, the granitic crust on either side of the fracture rests, at this stage, upon a sloping surface of the basaltic layer beneath, and sliding down over it, compresses the mass of sediment, throwing it into folds and developing thrusts.

These processes account for the contorted character of the rocks in mountain ranges, but their upheaval was a later event, explained by Daly as follows:—

"The deep roots of the mountains were at first cool; after millions of years the heat, slowly conducted up from the interior of the planet, could not fail to raise the temperature of the deeply sunken rock and even to melt some of it. Heating and melting caused expansion which meant that the crumpled mass above was as slowly but effectively uplifted. Following the upheaval, the many valleys have been cut by the rivers so invigorated, and between the valleys are the existing picturesque peaks and ranges."

The book closes with a masterly discussion of modern views, including those of the author himself, concerning the origin and present distribution of the continents, and the reader is asked to "remember that speculation is not science or knowledge," it "can do no more than point the way to possible future knowledge. Though it may stand on the right path, the signpost is not the goal itself."

There are 187 illustrations, many of the diagrams illustrating the author's own views; and there is a special note to the effect that with certain exceptions it is the author's wish that they shall be freely used for reproduction in textbooks and in technical papers.

F. J. NORTH.

Ancient Cities and Modern Tribes: Exploration and Adventure in Maya Lands. By THOMAS W. GANN, F.R.G.S., F.R.A.I., M.I.C.S. (Gerald Duckworth & Co. 21s.).

Dr. Gann may well express satisfaction at the results of his journey in Honduras in 1925-26. Probably few expeditions of equally short duration have produced more important or more numerous discoveries in the archaeological field of Central America. One of the main objects was to find unrecorded examples of the stelae or carved pillars, on which it was the custom of the ancient Mayas to record important or significant dates. The interest of the monuments which Dr. Gann discovered was so great that, to his readers at least, it affords some compensation for the fact that the number of dated stelae was not greater; while the stela found at Uberos on Chetumal Bay atones for many disappointments. This stone, twelve feet long, eighteen inches broad, and twelve inches high, lay on and partly buried in the ground. When turned over it was found to have preserved by its burial of a thousand years or so the Maya Initial Series 9.8.0.0.0. or A.D. 333, the oldest by nearly three centuries of the four Initial Series found in Yucatan. The importance of this date can hardly be exaggerated. If it is contemporaneous, as is probable, it shows that the Maya had a firm foothold in Yucatan long before it was supposed to be inhabited at all, and when the Maya were supposed still to live in the north. Further, Ichpaatun, as this site has been called, appears to have been a centre of several separate and distinct branches of culture, each one of which is of more than ordinary interest to the archaeologist.

On leaving Ichpaatun, Dr. Gann visited Chichen Itza, the greatest of the Maya cities, which was also held by the Toltecs in the eleventh century. Dr. Gann describes the remarkable work of restoration and preservation which is being carried out here by the American archaeologists. When this work is completed, Chichen Itza will be a noble record of a great artistic past. A tentative examination of the subterranean cavern, "The Cave of Flowers," produced no tangible result, though Dr. Gann's arguments that discoveries relating to prehistoric man may be expected when these remarkable caves are systematically examined appear fully justified.

Another discovery of moment was that of the great ruined city of Coba, a site which the author had been induced to visit by a phrase in a recent translation of the Maya chronicle of Chilam Balaam. The result was the discovery of a city approached by a broad stone processional terrace road of many miles' extent, which not only exhibited many unique and unrecorded features in Maya architecture, but seems to have been older and more important than the imperial city of Chichen Itza. Dr. Gann also accompanied the American Expedition under Dr. Morley, which repeated the observations made at Copan with a view to correlating the dates of the Maya records with those of the Christian calendar—needless to point out, this is an investigation of vital interest to American archaeology—and joined Lady Brown, Capt. Joyce, and Mr. Mitchell-Hedges

in this work of exploration at Labaantun. In the record of his previous year's journey, Dr. Gann gave some account of this remarkable site, unique in Central America. He now describes some of the features laid bare in last season's exploration, which have added to its significance and also, be it said, to the puzzle of its culture.

Dr. Gann does not confine his narrative to the archaeological side of his expedition, and the incidents of his journey here and there through a country always overgrown with vegetation and sometimes trackless, are recorded with a keen eye for the humours of native peculiarities which are numerous and varied. Dr. Gann sketches the plans for his next journey; we hope it may be followed by an equally entertaining and instructive volume.

E. N. FALLAIZE.

Report of the Oslo Conference. Published by the League of Red Cross Societies, Paris. (2*s.* 6*d.*).

The health and welfare of merchant seamen was the subject of an international conference which met in Oslo last June, under the auspices of the Norwegian Red Cross Society and of the League of Red Cross Societies. The report of the con erence has now been issued, and is the first document of its kind presenting international data on this subject. This fact alone gives it a special value, apart from the interest of the reports made by the delegates, which throw fresh light on a problem too often neglected in the past. One point stands out from all the discussions: the seaman is a world citizen; his welfare cannot be cared for by any one country. Many of the delegates referred to this obstacle, after having enumerated the measures taken in their own country to protect seamen. It is always the foreign port which is the sink of iniquity. Fortunately for the seaman, every foreign port is in a sense a home port too, and the discussions revealed a very real desire to extend the work already being done for seamen of all nationalities in the large ports of the world. The presence in Oslo of delegates from the League of Nations and the International Labour Office, as well as of representatives of the shipowners' and seamen's organizations, should ensure the interest and support of the authorities concerned.

The immediate object of the conference was to bring together representatives of the maritime red cross societies, and other organizations interested, to study the welfare of seamen and to examine what the Norwegian Red Cross Society had already done in this field. Briefly summarized, the achievements of this bod are the establishment of twenty-one medical stations in Norwegian ports, the publication of a medical manual for ships not carrying a doctor, and the preparation of a standard medicine chest—pioneer work which must be extended to the international field before its full value can be realized.

Three dangers that seem specially to menace the health of seamen—tuberculosis, venereal, and tropical diseases—were dealt with by the conference. The report made by Captain Tönnesen, of Norway, showed how easy it is under present conditions for a tuberculous seaman to take ship and to infect his comrades on board. Dr. Bourguin, of France, pointed out that it would not be a difficult matter to extend the existing system of tuberculosis dispensaries to include special dispensaries for seamen. Venereal diseases are a very special danger to the seaman because of his roving mode of life, and Dr. Ustvedt of Norway touched the heart of the problem when he asserted that the real task was to change the attitude of apathy and fatalism of the seaman himself towards these diseases. Reference was also made to the need for an educational campaign with regard to tropical diseases, which claim many victims through ignorance of methods of self-protection in tropical climates.

The conference passed eight resolutions, recommending *inter alia* the establishment of bureaus for furthering the health and welfare of seamen in all seaport towns, and the appointment of a standing committee on the welfare of seamen. This body will have the task of investigating facilities for the medical treatment of seamen, the standardization of medicine-chests and manuals, the establishment of a wireless code for medical consultations at sea, and the provision of recreational facilities for seamen of all nationalities.

Chemistry in the World's Work. By H. H. HOWE. (Chapman & Hall Ltd. 15*s.*).

This volume in the Library of Modern Sciences, by a well-known editor of American technical publications, is a brightly written and well-illustrated account of the great benefits contributed to the welfare of mankind by the discoveries and technical processes of chemistry. It is addressed in the first instance to the American public just as a book of a similar kind, Prof. Findlay's "Chemistry in the Service of Man," was addressed a few years ago to our own.

Mr. Howe certainly develops his thesis with great enthusiasm and with a wealth of telling illustration. No reader of this book could fail to be impressed with the importance of chemical processes in revealing new sources of wealth available to all mankind, or in converting material hitherto regarded as useless into a valuable luxury for our generation and an indispensable necessity for the next. The purification and preservation of food, the possible synthesis of foodstuffs; the manufacture of glass, of special steels for motor cars, of stainless steel for household purposes; the industries of electro-plating or of artificial silk making; the manufacture of petrol and illuminating oils from coal, and of fertilizers from the gases of our atmosphere; all these and many other subjects are described at some length in this work. Anyone who would like to know about these wonderful processes cannot fail to be interested in this comprehensive book. Any, if there be any, who fail to realize the importance of chemistry on the material basis of our civilization, I would commend to the following extract which is quoted by Mr. Howe in this book:—

"What does chemistry mean to me?" said Mr. Narrowhead as he looked at this page, printed with ink made by a chemical process, on paper made by a chemical process.

As he pushed back his cuff, bleached by a chemical process, he glanced through a pane of glass, made by a chemical process, and saw a baker's cart full of bread, leavened by a chemical process, and a draper's wagon delivering a parcel of silk, made by a chemical process.

He pulled out his pencil, made by a chemical process, and wrote a reminder in his notebook bound in imitation morocco, made by a chemical process, then put on his hat, dyed by a chemical process, stepped out on the pavement of asphalt, compounded by a chemical process, bought a daily paper with a penny, refined by a chemical process, and proceeded to the office where he dealt in a certain chemical compound called coal.

"No," he added, "of course not, chemistry has nothing to do with me."

A. S. R.

Italiano, Parte Prima: Lezioni 1-5. (Pelman Languages Institute).

There will always be many people who are too lazy to learn, and who will be attracted by any method of acquiring information that appears to save them the trouble usually associated with orthodox study. It is because the course of instruction it embodies will not appeal to the sluggard that

the Pelman language system, of which we have received a booklet of lessons for review, is to be welcomed as a serious contribution to teaching. On the other hand, for the reason that the course has seized upon and logically adapted an attractive method to its purpose, it should certainly persuade many to learn who have been discouraged from acquiring knowledge of a language through the usual channels.

The method is an advanced form of teaching by association of ideas, achieved by employing pictures. On the basis of a simple scene, a series of sentences, usually in the form of question and answer, are presented in the foreign language but without English translation, one phrase leading up to another slightly more complex. It may be doubted how far an accurate knowledge of grammar and syntax can be acquired in this way, yet a close examination of the lessons indicates that much more can be introduced by judicious repetition than would at first seen apparent. Though the problem of pronunciation is undoubtedly dealt with later in the course, it is open to question how far the student will remember the words and phrases learnt in the earlier lessons if he subsequently finds that—albeit unwittingly—he has so far formulated some fundamental phonetic phrase entirely inaccurately.

These points lead one to suppose that the courses would be of particular value to those who have already mastered the elementary facts but have failed as yet to get an ordered conception of the principles on which to build. The analogy is not entirely accurate because the method under review plans to cover detail more fully; but so-called "cramming" courses are frequently found of the greatest service to the serious student—not so much because facts are condensed to the exclusion of the essential as because they are thereby reduced to order in his mind. So far as may be gathered from the elementary lessons, the Pelman system enables the student to start with this definite advantage.

Popular Experiments in Dynamics. By G. C. SHERRIN. (George Philip & Son Ltd. 20*s*.).

The price given above is for an apparatus designed by the author for demonstrating popular experiments in dynamics and for an illustrated handbook which accompanies it. The parts of the apparatus are of such a nature that they can be assembled in a variety of ways to illustrate a large number of experiments in mechanics. One of the first models described in the book is that of the Moon revolving round the Earth and the Earth round the Sun; in a separate model the axial rotation of the Moon is shown very clearly and, in a third, the laws which prevent the Moon from gravitating to the Earth are demonstrated.

With the apparatus supplied and from the instructions of the book several models illustrating centrifugal force may be simply constructed; gyroscope precession may also be shown. Directions are given for constructing and making use of Galileo's pendulum and Foucault's pendulum. Flettner's rotatory cylinder for converting the energy of the wind into motion of a ship is also illustrated.

I have constructed with the parts supplied most of the models illustrated in the handbook. The fitting together was found to be simple, and I had no difficulty in making the final model work. I should judge that for anyone interested in mechanics a gift of this apparatus would be instructive and welcome. It would be wrong to compare the interest a purchaser would have in this apparatus with that given by a valve-model wireless set: the theory underlying the experiments performed by the apparatus, however, is simpler to follow than the theory of wireless, and it is knowledge that should be in the possession of every intelligent member of a civilized community. I hope this apparatus will make a wide appeal. It certainly deserves to do so.

A. S. R.

Books Received

An Asian Arcady. By REGINALD LE MAY, M.R.A.S. (W. Heffer & Sons Ltd. 21*s*.).

The Igneous Rocks of the Mountsorrel District. By E. E. LOWE, B.Sc., Ph.D. (London Agents, Thomas Murby & Co. 6*s*. 6*d*.).

Catalysis in Theory and Practice. By ERIC K. RIDEAL and HUGH S. TAYLOR. (Macmillan & Co. Ltd. 20*s*.).

A Short History of Botany. By R. J. HARVEY-GIBSON, C.B.E., D.L., M.A., D.Sc. (J. M. Dent & Sons Ltd. 2*s*. 6*d*.).

Elementary Botany. By W. WATSON, D.Sc. (Edward Arnold & Co. 6*s*. 6*d*.).

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A Servant of the Mightiest. By MRS. ALFRED WINGATE. (Crosby Lockwood & Son. 7*s*. 6*d*.).

Colour Music: The Art of Light. By A. B. KLEIN, M.B.E. (Crosby Lockwood & Son. 30*s*.).

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Biology and Human Life. By PROFESSOR J. S. HUXLEY, M.A. (The British Science Guild. 1*s*.).

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Edison: The Man and his Work. By GEORGE S. BRYAN. (Alfred Knopf. 18*s*.).

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Rome, the Law-Giver. By J. DECLAREUIL. History of Civilization Series. (Kegan Paul, Trench, Trubner & Co. Ltd. 16*s*.).

Primitive Italy. By LEON HOMO. History of Civilization Series. (Kegan Paul, Trench, Trubner & Co. Ltd. 16*s*.).

To America in Thirty-nine Days. By JOSEPH BIGGS. (The Village Press. Idbury, Kingham. Oxon. 3*s*. 6*d*.).

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The Elements of General Zoology. By WILLIAM J. DAKIN, D.Sc., F.Z.S. Oxford University Press. 12*s*. 6*d*.).